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ABSTRACT

This final report of a project conducted to design, develop, and test a comprehensive management plan for vocational education in Missouri is divided into three sections. Section I describes the rationale and components of a model based on the general systems approach to planning. An analysis of the planning process introduces several planning tools that were developed. Section II presents detailed examples of the application of one component of the planning model, The Decision Making Support System, the essence of which lies in the application of quantitative tools to the analysis of vocational education planning problems. The applications explained include linear programing, goal programing, multivariate statistics, and heuristic methods. Resource allocation planning problems are dealt with as well as the problems of needs assessment and of projecting employment for planning purposes. Section III addresses a variety of issues that relate to improving vocational education planning. The question, "Is improving vocational education planning more myth than reality?, is dealt with. Barriers to improving planning are discussed as well as the effect of the lack of administrative responsibility as it relates to vocational education planning. The report concludes by considering the possible future of vocational education planning. Appended are a discussion of data gathering and analysis and a copy of the operational master plan for vocational education in Missouri through the year 1990 that evolved in part as a result of this study. (Author/LMS)

IMPROVING VOCATIONAL EDUCATION PLANNING: MORE MYTH THAN REALITY?

FINAL REPORT

By

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Project Number 498AH50147

A Project to Design, Develop and Test a Comprehensive Management Plan for Vocational Education in Missouri

Grant Number G007500317

Research Project in Vocational Education
Conducted Under
Part C of Public Law 90-576

Department of Practical Arts and Vocational-Technical Education
University of Missouri - Columbia

March, 1977

PREFACE

This report deals with improving the planning of vocational education. Recent emphasis regarding both the lack and poor quality of vocational education planning has culminated in stringent federal vocational education legislation that emphasizes the importance of the planning process. In this era of accountability, improving the planning of vocational education at all levels has become a paramount concern. The problems, processes, and ideas discussed in this report address this concern.

The report is divided into three sections. Section I, A Vocational Education Planning Model, describes a model based upon the general systems approach to planning. The rationale for the design of the model is explained and each component is presented. The vocational education planning process is analyzed and several planning tools that were developed are introduced. Section I exemplifies the need for a rational model to plan vocational education and seeks to fill this void.

Section II presents detailed examples of the application of one component of the planning model, The Decision Making Support System. The essence of this system lies in the application of quantitative tools to the analysis of vocational education planning problems. The applications that are explained are innovative to vocational education planning. They include linear programming, goal programming, multivariate statistics, and heuristic methods. Resource allocation planning problems are dealt with as well as the problem of projecting employment for planning purposes and determining the number of persons in need of vocational education services. The explanations are quite detailed and a variety of technical matters are dealt with.

Section III of the report addresses a variety of issues that relate to Improving Vocational Education Planning. The question, "Is improving vocational education planning more myth than reality?", is dealt with. Barriers to improving vocational education planning are discussed as well as the effect of the lack of administrative responsibility as it relates to vocational education planning. The report concludes by considering the possible futures of vocational education planning.

The report contains two significant appendices. The first describes the process by which the data that were needed for the planning model were gathered and analyzed. Some of the data are displayed. The second appendix consists of the operational master plan for vocational education in Missouri through the year 1990 that evolved in part as a result of this study. The planning model described in this report was utilized in developing the Missouri vocational education plan.

It is suggested that the ambitious person read this entire report. However, for those with less expendable time, the following guidelines are suggested.

Interest	Reading Suggestion
Barriers to Planning	Scan Section I and Read Section III
Improving Planning	Read Sections I and III
Administering Planners	Read Sections I and III and Scan Section II
Preparing Plans	Read Sections I, II, and III
Adopting Planning Model	Read Entire Report Carefully and Refer to the Bibliography for Further Sources

James A. Pershing
Project Manager

ACKNOWLEDGMENT

The investigators wish to acknowledge the assistance and cooperation provided by several individuals and groups in making this project possible. Appreciation is offered to the Division of Career and Adult Education of the Missouri Department of Elementary and Secondary Education for providing impetus for the vocational education planning study. Mr. B. W. Robinson, Assistant Commissioner and State Director of Vocational Education; Dr. Frank Drake, Coordinator of Vocational Education; and Mr. Homer E. Bolen, Coordinator of Special Services deserve recognition for the strong leadership they provided to the planning study.

The committee that was charged by the State Board of Education to make a study of vocational education in Missouri and to blueprint the vocational education program needed for the future deserve acknowledgment. The eighteen member study committee, known as TASK FORCE 1990, provided the questions and raised the concerns that led to the products reported in this document. Dr. Robert Worthington, the TASK FORCE 1990 Director, provided excellent leadership to the committee; and it was a pleasure to work with him on the project.

The research project was fortunate to have a distinguished panel of consultants to provide external advice to the research team throughout the project. Their insight and counsel were invaluable. The panel included: Dr. James Harris, Management Information Supervisor, Colorado State Board of Community Colleges and Occupational Education; Dr. Marvin Linson, Professor of Vocational Education, Colorado State University; Dr. Rutherford Lockette, Chairman, Division of Vocational Education and Practical Arts, University of Pittsburgh, Pennsylvania; Mr. Thaine McCormick, Director, Occupational and Adult Education, Regional Office, Health, Education and Welfare, Kansas City, Missouri; Dr. Byrl Shoemaker, State Director of Vocational Education, Columbus, Ohio; Dr. Elizabeth Simpson, Dean, School of Family Resources and Consumer Sciences, University of Wisconsin, Madison; and Dr. Francis Tuttle, State Director of Vocational Education, Stillwater, Oklahoma.

Special acknowledgment is offered to the following persons for their contribution to the project: Dr. S. Craig Moore, Associate Professor of Industrial Engineering, for assisting with several of the operations research methods used in the project; Dr. David W. Stevens, Associate Professor of Economics, for assisting with the technical aspects of

projecting employment; and Mr. Allen Tacker, Systems Analyst, for collecting, processing, and analyzing large amounts of the data that were utilized in the project.

Special gratitude and acknowledgment are extended to Dr. Jim W. Atteberry, Project Associate, for his contribution. The planning model and many of its unique components are attributable to Dr. Atteberry. He labored through the first draft of this report and deserves a special thanks.

In the final analysis, this project would not have been possible without the encouragement and financial support provided by the Office of Education, United States Department of Health, Education, and Welfare. Dr. Jack Wilson, of the Division of Research and Demonstration, Bureau of Occupational and Adult Education, provided outstanding guidance to our research effort. He provided us with pertinent information about other research efforts dealing with related matters and shared with us his ideas regarding our research effort and the reporting of those efforts.

Columbia, Missouri
March, 1977

Wilbur R. Miller
Principal Investigator

and

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Project Manager

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SECTION I

A VOCATIONAL EDUCATION PLANNING MODEL

CHAPTER I

A SYSTEMS MODEL FOR PLANNING VOCATIONAL EDUCATION

Background for Study

The failure of state and local agencies to plan vocational education programs adequately has been a topic of concern for quite some time. This concern was expressed by the U.S. Congress in preparing the 1963 vocational education legislation, the 1968 legislation, and most recently in the preparation of the 1976 legislation. This concern was highlighted by the General Accounting Office Report to the Congress in 1974[1] and numerous National Advisory Council Reports over the years. The inadequacies in the planning of vocational education permeates vocational education literature.

Explicit in these studies has been the belief that better planning will improve the performance of vocational education. Unfortunately, the impact of these studies on improving the planning of vocational education is questionable. Too frequently, it seems that generalizations about

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[1]Report to the Congress, Office of Education, Department of Health, Education, and Welfare, What is the Role of Federal Assistance for Vocational Education?, by the Comptroller General of the United States, B-164031(1) (Washington, D.C.: United States General Accounting Office, 1974), p. 5.

planning are made, recommendations are forthcoming, but few specific changes occur, so things remain the same. The bridge between recognizing the need for better planning and implementing specific solutions is seldom completed.

It is against this background that this research project was designed and developed. The project evolved from a statewide study of vocational education sanctioned by the Missouri State Board of Vocational Education. Representatives from education, business, labor, government, and other human resource programs were asked to participate as members of the statewide study group. This group, which became known as Task Force 1990, was charged with the responsibility of developing a long range plan for vocational education in Missouri through the year 1990.

Early in their investigation, the Task Force found there was a need to improve the planning of vocational education at the state level. The Task Force decided that the development of a rational planning system would improve the planning and performance of vocational education in the state. It was thought that the system, once developed and tested, would meet two needs. First, the system would assist the Task Force in answering questions pertaining to the formulation of the long range plan they were to develop. Second, the system would fill the need for a permanent planning system for vocational education at the state level.

Since the development of such a planning system required resources and expertise not available to the Task Force, a team of vocational education researchers of the Department of Practical Arts and Vocational-Technical Education (PAVTE) at the University of Missouri-Columbia (UMC) was asked to work with the Task Force in conducting the statewide study. The expected result of this joint effect was a long range plan for vocational education as well as a permanent planning system. Fortunately, the University was able to obtain financial support from the U.S. Office of Education to develop a planning system.

Purpose of the Project

Succinctly stated, this project dealt with improving the planning of vocational education in Missouri. Given this purpose, the following steps were taken: first, design a planning system; second, test the planning system through the development of an operational plan; and finally, implement the system on a permanent basis. An awareness that many past efforts to improve planning have failed made the investigators skeptical. This skepticism, in turn, is reflected in the title of this report that is: Is the improved planning of vocational education more of a myth than a reality? It is hoped that some insight into the answer of this question is provided through this report.

The method of approach is as follows: In Section I the design and development of the planning model is described.

In Section II the specific application of parts of the planning model to the planning of vocational education in Missouri are presented. Finally, in Section III findings and recommendations regarding the improvement of the system of planning vocational education in Missouri, as well as in other states, are offered.

Overview of the Design of the Planning System

In the design and development of the planning system a "systems approach" was employed. The underlying premise of a systems approach is to think of planning as a whole process rather than just a series of events. Such a process should be perceived as being comprised of many interacting elements whose behavior can only be understood through an analysis of the entire system. The basic elements of any system can be described as:

1. Input - anything taken into the system,
2. Output - anything generated outward from the system,
3. Processors - mechanisms that convert input to output,
4. Feedback - output resulting from past decisions used as input to alter the existing state,
5. Environment - external surroundings or circumstances that may influence inputs, the process itself, outputs, or even the feedback loop.

Schematically, the basic elements of a system are depicted in Figure 1.

The process of planning vocational education is a very complex process. Many of the elements of the process

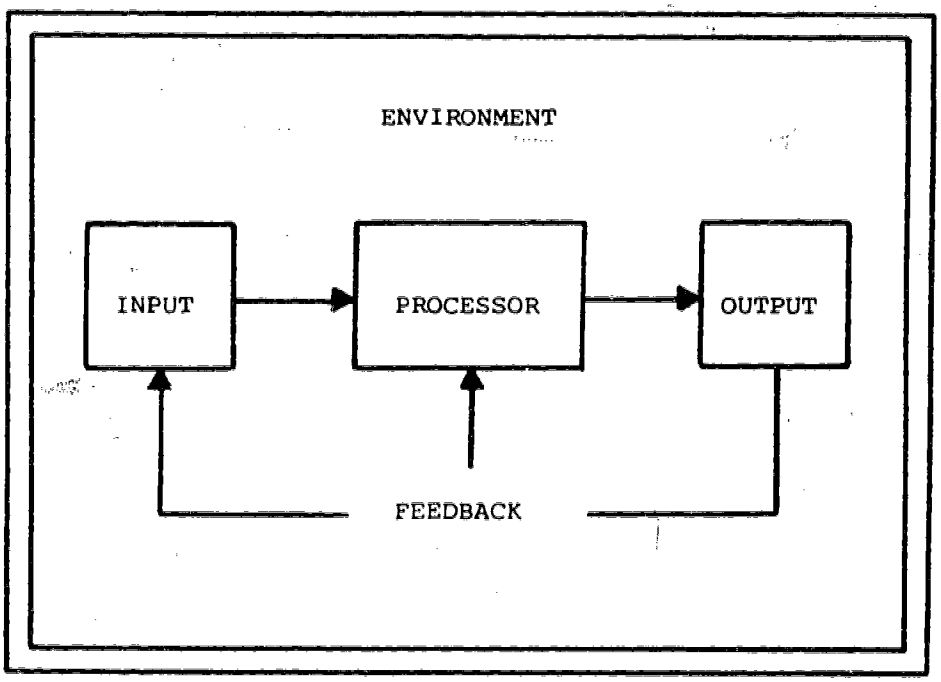

Figure 1

Basic Structural Elements
of a System

can be depicted as subsystems. In the development of the systems model for planning vocational education the following five subsystems were identified (Figure 2):

1. Strategic planning and policy determination,
2. Administrative planning,
3. Management information system,
4. Decision-making support system,
5. Evaluation system.

Accordingly, the remaining chapters of this section explain the function and purpose of each of these subsystems. Along with the explanations, specific examples will be given regarding the use of each subsystem in the planning of vocational education.

SYSTEMS MODEL FOR PLANNING AND MANAGING VOCATIONAL EDUCATION

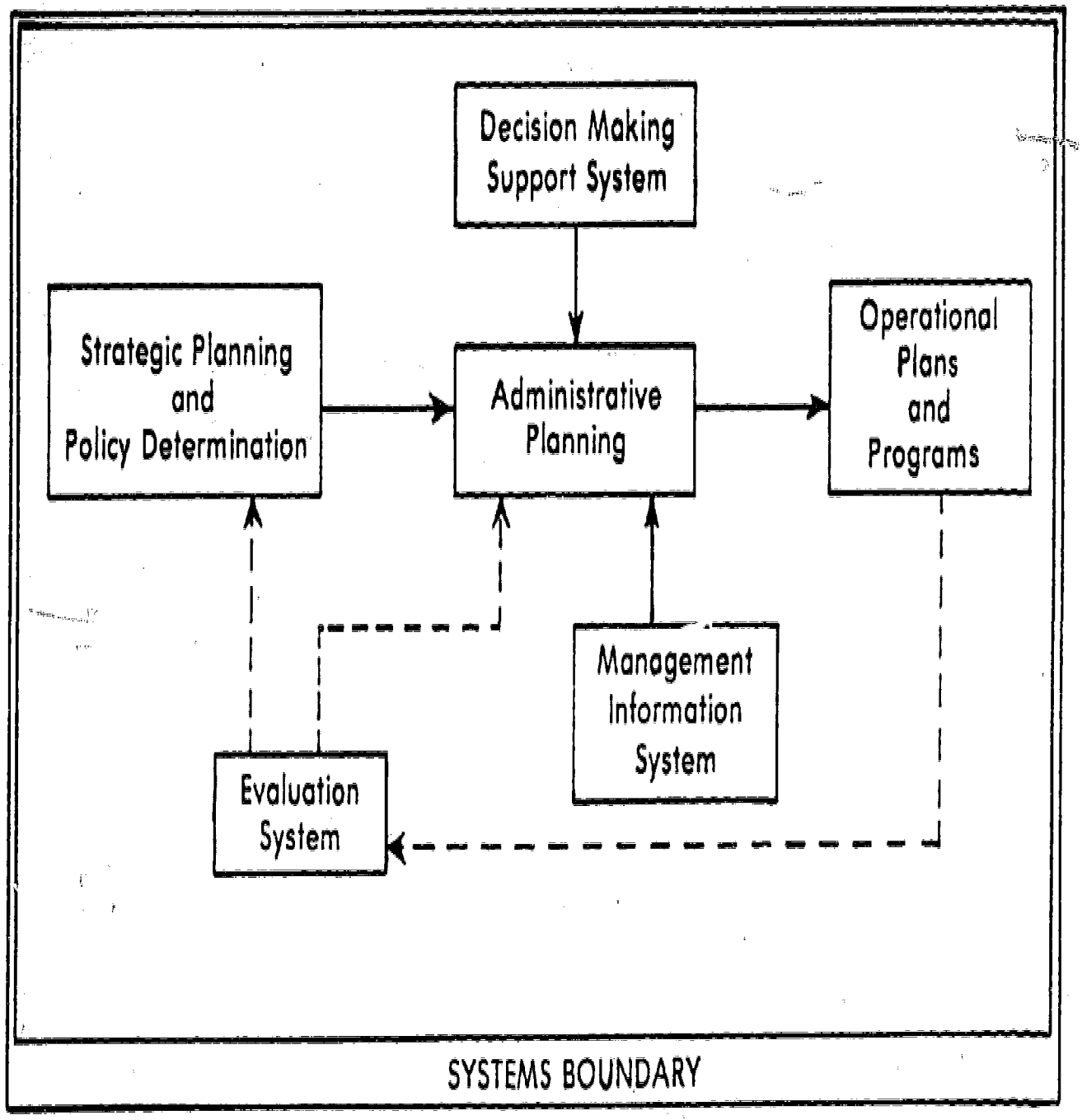

Figure 2

CHAPTER II

DISTINGUISHING STRATEGIC PLANNING FROM ADMINISTRATIVE PLANNING

It is important that the difference between strategic planning and administrative planning be clearly understood. The difference, although it may at first appear to be subtle, requires completely different methods and procedures in the planning of vocational education. In this chapter, the purpose of each is delineated.

Strategic Planning and Policy Determination System

Strategic planning is the process of developing plans that deal with broad matters which affect the direction of the vocational education system. Stated another way, the strategic planning process involves specifying goals for the vocational education system. Policy determination, which is very similar to strategic planning, is the process of setting general statements that guide decision making. Policies set the boundaries within which decisions are to be made. In this sense, policies direct the decision maker toward the accomplishment of the goals of the vocational education system.

The process of strategic planning and policy determination, in effect, chart the course for the vocational education system.

Obviously, strategic planning and policy determination processes are important functions in the planning process. Unfortunately, this phase of the planning process has not received much attention in the literature on vocational education planning. In view of this void, a system which should serve as a model for strategic planning and policy determination was developed through this project.

The development of this system was based on the recognition that vocational education must be responsive to the needs of the people it is designed to serve. To assure responsiveness the clients and constituents of vocational education must be involved in this phase of the planning process. Examples of groups that need to be represented are:

1. Students and parents,
2. Representatives of local administrators,
3. Key administrators and staff at the state level,
4. Representatives of state and local advisory councils,
5. Representatives of business, industry, and labor,
6. Representatives from other agencies involved in human resource development.

In the next part of this chapter an example is given of the application of the strategic planning system in Missouri. The reader should be attentive to the role of the client groups in this phase of the planning process.

The assumption is, that the process as described, will serve as a guide to other states in meeting the one and five year planning requirements of the 1976 vocational education legislation.

An Example of Strategic Planning

An application of the strategic planning and policy determination system is Missouri is described as follows: The State Director of Vocational Education in Missouri, Mr. B.W. Robinson, was charged by the State Board for Vocational Education to initiate a comprehensive study of vocational education in the fall of 1975. The study was to focus on making recommendations which would serve as guidelines for the future growth and development of vocational education in the State of Missouri for the 15-year period 1976-1990.

The State Director of Vocational Education appointed a 19-person committee, directed by Dr. Robert Worthington, to study the state-wide program of vocational education. Task Force 1990, as this committee became known, consisted of representatives from the Missouri House of Representatives and Senate; representatives from the executive branch of state government (Departments of Industrial Development, Manpower Planning, and Administration); teachers of vocational education representing the various service areas; area vocational school

directors; deans of community colleges; superintendents of comprehensive high schools; vocational teacher educators; and the State Advisory Council. Simultaneously, with the establishment of the Task Force group, a team of Vocational Education researchers at the University of Missouri-Columbia was solicited to serve as the research arm for the Task Force. In addition, an external group of consultants was identified to assist in the research effort. This group met with the UMC Research Team and representatives of the Task Force in the initial stage of developing research procedures and data sources.

In order to expedite the work of the Task Force, as well as to provide a structure for the work of the University of Missouri Research Team, the Task Force group was organized into six subcommittees. In addition, 60 individuals from throughout the State of Missouri were selected to serve as members of these subcommittees. These additional individuals were chosen because of their interest or involvement in a variety of groups such as industry, labor, civic organizations, proprietary schools, industrial development groups, and other state agencies.

Even though there was considerable variety in the different areas which the Task Force and the UMC Research Team dealt, the procedures by which each of the subcommittees worked were quite similar. The Task Force, as a total group, met on a bi-monthly basis at which time the UMC Research Team members were present along with Dr. Worthington, the

project director. The chairpersons of each subcommittee presented a report of their subcommittee's activities. The Research Team reported on research activities that had relevance to more than one subcommittee. Between the bi-monthly meetings of the entire Task Force, the subcommittees met once or twice each month. A member of the UMC Research Team met with them in order to convey information, assist the subcommittee members in interpreting data, and learn first-hand the additional data needs of each subcommittee.

In short, each subcommittee went through the following steps in their deliberations:

Phase I: Problem exploration,

Phase II: Knowledge exploration,

Phase III: Priority development,

Phase IV: Program development.

After more than a year of subcommittee and UMC Research Team activity, the team of external consultants returned to the state for a session in which the chairpersons of the six subcommittees made reports of their activities, major findings, and conclusions. This session provided members of Task Force 1990 with an opportunity to have their investigative procedures and conclusions verified by the professional judgment of an experienced group of leaders in vocational education.

The subcommittee chairpersons, with the assistance of the UMC Research Team, finalized their subcommittee reports which were then presented to the full Task Force during the

summer of 1976. The project director, Dr. Robert Worthington, then assumed the responsibility for preparing a summary report including recommendations.

The activities of Task Force 1990 culminated in the development of strategic plans and policies to guide vocational education in the years ahead. (See Appendix II for further explanation and a list of Task Force 1990 recommendations.)

The Strengths of the System

The strengths of the strategic planning and policy determination process as applied to planning vocational education in Missouri are:

- The involvement of all constituent groups that have an interest in vocational education program planning is guaranteed.
- Strategic planning and policy determination are presented as a discrete series of phases from problem exploration to program evaluation.
- The interaction of client groups and state administrative personnel illuminates the needs and concerns of each group.
- The output of the process provides state administrators of vocational education with goals, objectives, and policies to guide them in the administration of programs.

The process itself should prove to be invaluable to the growth and development of vocational education in Missouri. As the situation demands, it is expected that yet another

study group will be convened to plan for the future of vocational education in Missouri.

Administrative Planning System

Strategic planning and policy determination are important to the process of planning vocational education programs. Administrative planning is equally important with the difference being simply one of purpose. Administrative planning deals with the development of operational plans that guide the vocational education system in the use of resources so that the goals of the system are accomplished.

Improving Administrative Planning

Improving administrative planning may very well be the most important key to improving the state-wide program of vocational education. In the management of organizations in the business sector, a variety of techniques or tools have been developed to assist in administrative planning and decision making. Such tools, commonly known as operation research tools, are: simulation, linear programming, cost-benefit analysis, and network planning methods.[2] These tools have contributed significantly to the development of operational plans so that the use of the organization's resources are employed most effectively. Unfortunately, these tools, although applicable to vocational education planning, have

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[2] T.W. McRae, Analytical Management (Glasgow, Great Britain: The University Press, 1970), pp. 2-9.

received little attention by vocational educators. The failure of state administration to employ these tools stems from a lack of sophistication, relative to planning, on the part of those responsible for vocational education programs. In the past, the study of such tools has not been included in the professional preparation of administrators. In the future, vocational administrators need to be trained in the use of these tools so the benefits of the techniques can be realized.

One of the more important findings of Task Force 1990 was that the planning of vocational education needed to be improved. The study found that planning was done primarily to comply with the state planning requirement of federal vocational education legislation. They found that the State Plan itself was not adequately used to guide the vocational education system but served primarily as a document to satisfy federal requirements.[3]

In the Task Force's deliberations it was concluded that the state administration had been unable to improve the planning process because of a lack of specialized planning skills or human resources to devote to the process. Thus,

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[3]Career and Adult Education (MDESE) and the Department of Practical Arts and Vocational-Technical Education, College of Education, A Project to Design, Develop and Test a Comprehensive Management Plan for Vocational Education in Missouri, Unpublished working papers and reports of TASK FORCE 1990 (Missouri: University of Missouri-Columbia, 1976).

The Task Force concentrated on the formulation of recommendations specifying ways to improve the planning process.

The responsibility of identifying ways to improve the process was delegated, as already mentioned, to the UMC Research Team. Investigative efforts led to the development of the planning model presented as Figure 2 of Chapter I and, in turn, to the development of a decision making support system as part of this model.

Specifically, a decision-making support system was designed that will make operations research tools available to the vocational education administrator. In turn, it is anticipated that the use of these tools will improve the administrative planning of vocational education. In addition, recommendations were made regarding the design and improvement of management information systems for vocational education planning.

In essence, it is the contention of the investigative team that the improvement of administrative planning rests on the development of a decision making support system and the improvement of management information systems. Both of these issues will be discussed in Chapters III and IV.

Summary

The difference between strategic planning and administrative planning is one of purpose. The purpose of strategic planning is to develop and specify the goals of the vocational education system. The purpose of admini-

strative planning, on the other hand, is the development of operational plans to guide the vocational education system in the accomplishment of goals. Accordingly, administrative planning follows strategic planning.

Strategic planning, as presented in the systems model, should be done by the clients and constituents of vocational education and not entirely by state administrators, as is often the case. Client and constituent involvement is advocated to improve the responsiveness of the vocational education system. An example was given of the process of strategic planning, whereby these groups were involved in the development of a long range plan for vocational education in Missouri.

To improve the administrative planning of vocational education in Missouri two changes were proposed. The first was the development of a decision-making support system. The second, was the improvement of the management information system as used in planning vocational education. These systems, discussed in future chapters, are designed to eliminate the problems resulting from a lack of planning information and techniques necessary to analyze the information. The expected result, of course, is the improvement of vocational education planning.

CHAPTER III

THE MANAGEMENT INFORMATION SYSTEMS MIRAGE

It is difficult to describe MIS systems in vocational education in a satisfactory way. It seems that the concept is embedded in a mish-mash of fuzzy thinking and incomprehensible jargon. Although description is difficult, the products, or more precisely the lack of products of such systems are well documented.[4] It is not unfair to say that information for planning which is current, accurate, and available does not exist on any meaningful scale in the majority of state vocational education agencies.[5] Until such information is available, the planning of vocational education is mere guesswork.

The idea that MIS systems are a mirage is based on an analysis of the type of information generated by the MIS system in Missouri and several other states. Conceptually, MIS systems can be classified on the basis of information or, in turn, the type of questions the

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[4]For an idea of the data available in Missouri refer to Appendix I.

[5]Jack A. Wilson, Improving the Administration of Vocational Education at the State Level, United States Office of Education (Washington: Government Printing Office, 1975), p. 8.

system helps the decision maker answer.[6] The classification employed in this project was as follows:

1. Operations or working information (answers questions like - how many students are enrolled in programs?)

2. Performance or control information (answers questions like - how are we doing?)

3. Planning or forecast information (answers questions like - where are we headed?)

4. Strategic or policy information (answers questions like - what should we be doing?)

It was found that MIS systems in vocational education typically provide operational or control information; rarely is the MIS used to provide information classified as planning or policy information. Simply stated, the potential of MIS systems in the planning of vocational education is not being realized. If the potential is to be realized, systems must be designed to provide information that aims at all levels of the above classification. Until the design of MIS systems are improved, their usefulness will remain more imagined than actual.

In this chapter, a brief description of problems with Missouri's MIS system is presented. This description is followed by recommendations for improving the design and operation of MIS systems in vocational education.

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[6] Sherman C. Blumenthal, Management Information Systems: A Framework for Planning and Development (Englewood Cliffs, New Jersey: Prentice-Hall, Inc. 1969.) p. 26.

Missouri's MIS System[7]

It is generally agreed that the major purpose of a management information system is to provide information that is accurate, relevant, and timely. This information is then used by management to make decisions and plans. In this Chapter Missouri's MIS system is analyzed relative to this purpose: the assumption being, that the analysis should provide insight for improving the operation of MIS systems in the planning of vocational education.

Overview of Missouri's MIS

The Missouri MIS, known as the Missouri Occupational Training Information System (MOTIS), was developed in 1972.[8] In theory, the system was designed to provide information to state and local administrators which would guide them in educational planning. The MOTIS system, as designed, consists of four components.

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[7]In conjunction with this section it is suggested that the reader refer once again to Appendix I for an overview of data problems encountered in demonstrating the analytical techniques of the decision making support system.

[8]Missouri Department of Elementary and Secondary Education, Research Coordinating Unit, MOTIS Technical Report, by James Pershing and Richard Tiller (Jefferson City, Missouri, 1973).

Component	Purpose
Manpower Demand Component	To estimate current and projected employment by instructional program code for the state and 13 geographic regions.
Manpower Supply Component	To estimate information on manpower supply.
Student Accounting Component	To inventory and follow-up students in state reimbursed vocational education programs.
Resource Inventory Component	To assemble an inventory file on vocational education facilities and personnel.

The relationship of each component is depicted schematically in Figure 3.

The responsibility for the development and operation of the system rests with the Research Coordinating Unit within the Missouri Department of Elementary and Secondary Education.

Problems with MOTIS

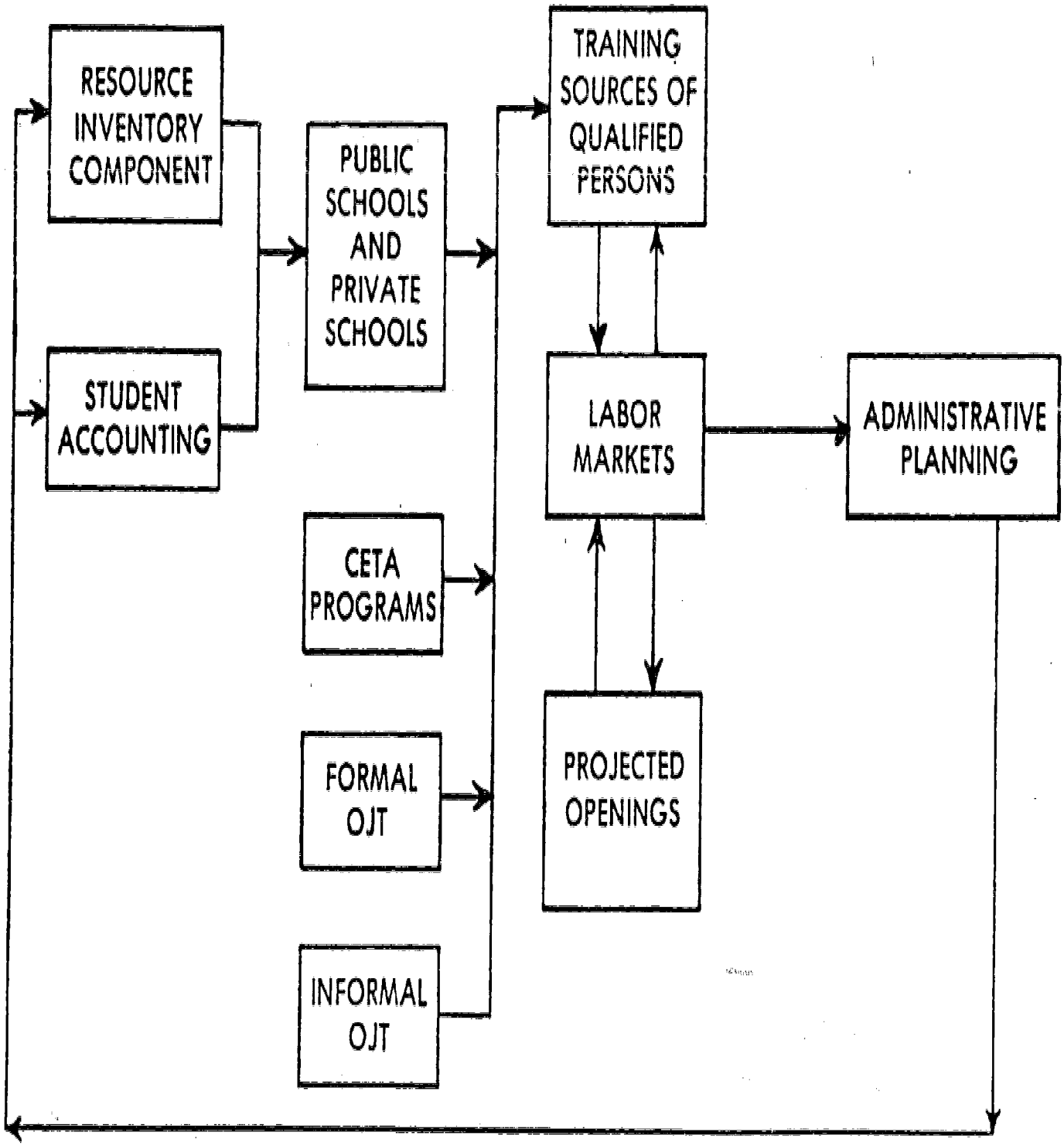
The MOTIS system has been plagued with problems from its original design to its current operation. There is no evidence that the system was designed to provide for a decision making support system. Instead, the system's design is dominated by activities dealing with the gathering of data on operations (i.e. student accounting component and resource inventory component).

Although the original design of the system could be improved, the more immediate problems concern current operations. The problems can be grouped in the following areas:

MOTIS

Figure 3

Missouri Occupational
Training Information System



- Inaccurate or incomplete data
- The system is not responsive to the information needs of the users
- The systems is only partially operational
- Management and control of the system

From an intensive review of the operation of the system, several problems of inaccurate or incomplete data were identified. It was found that vocational enrollments were duplicated. In several situations students were counted on the basis of courses in which they were enrolled rather than on the basis of program enrollment. For example, a student taking three home economic classes would be counted three times instead of once. The effect of this can be absurd. In a few districts more students were reported to be enrolled in vocational education programs at a given grade level than there were students in a particular grade in the school district. The result of such practices was to overestimate vocational enrollments for the state by as much as 30 percent.

Inaccurate data were juxtaposed with incomplete data. Some school districts simply do not report data. Follow-up data exists on only 20 percent of post-secondary completers. Seemingly, an absence of incentives or lack of commitment to report the data exists.

In an assessment of the MOTIS system local administrators were surveyed. They were asked if the MOTIS system aided them in planning their vocational education programs. Over 80 percent of the administrators stated it did not.

Based on other questions, the administrators' responses revealed that they questioned the accuracy of the data and indicated the information was not used for this reason. In turn, eighty-five percent reported the system did not meet their planning needs. The response from users at the state level was similar. Complaints were made about the accuracy of the data and the length of time required to get information on enrollments. As an example, enrollment for the school year 1975-1976 was not available by January 1977. In contrast, when enrollments were tabulated manually, the information was usually available by the first of January of the school year (i.e. that would be January of 1976--a year ahead of the computerized system). In short, state administrators claimed that such delays were typical, thus the system was not meeting their needs for information to use in the planning process.

If the system is to meet the needs of users the system must be made fully operational. At the present, only the manpower demand component and the student accounting component are in operation. The manpower supply component has not been implemented. Thus, planners at the state and local level do not have information on alternative sources of supply of manpower. In addition, the resource inventory component has not been implemented; therefore, state and local planners do not have data on program and facilities costs. Obviously, the planner needs information

on manpower supply and vocational resources if adequate plans for the delivery of vocational education are to be made.

However, the problem of management and control of the MOTIS system reigns over all the rest. In fact, if the management of the system is shifted, the other problems are likely to disappear. Currently MOTIS is controlled by the Division of Business and Internal Management of the Missouri Department of Elementary and Secondary Education (MDESE). In contrast, the primary user of the output of the system is the Division of Career and Adult Education in the MDESE. Thus, the user does not have control of the system. Unfortunately, the Division of Career and Adult Education has little influence over the division responsible for the system. This lack of influence means that the management of the system lacks accountability to the users and numerous problems result.

Improving MIS Design

From the preceding example several explanations of problems with MIS systems are obvious. Foremost among these is that too frequently inexperienced and/or inadequately trained individuals are given responsibility for these systems. This, however, is simply a manifestation of a larger problem. That is, administrators in vocational education fail to understand the purpose of MIS systems. This misunderstanding is, in turn, reflected in the design and control of such systems. Accordingly, in the next section a framework for the

development and design of MIS systems in vocational education is provided. This framework will illuminate the purpose and potential benefits of MIS systems.

Framework for MIS Development

In proposing this framework, it is recognized that no framework can claim universal validity on a subject of this scope and complexity. Simply stated, the processes and relationships are not subject to empirical verification. Consequently, this framework must be evaluated by each individual on the basis of the way in which it provides an understanding of the role of MIS systems in vocational education planning.

The objective of the framework is to provide a structure that will assist administrators in the development of a MIS system for vocational education. The purpose of this structure is to provide a system that is congruent with the information needs of the vocational education program it is designed to serve. To achieve this purpose, the framework must first aid the system's architect in envisioning the structure of the system. Secondly, it must point to the best way to get there from the present position. In Figure 4 the framework is presented.

The framework is a "top-down" approach in the sense that the process begins with an analysis of vocational education objectives. These objectives are commonly expressed at the highest level. Careful analysis of the objectives should reveal the areas in which vocational

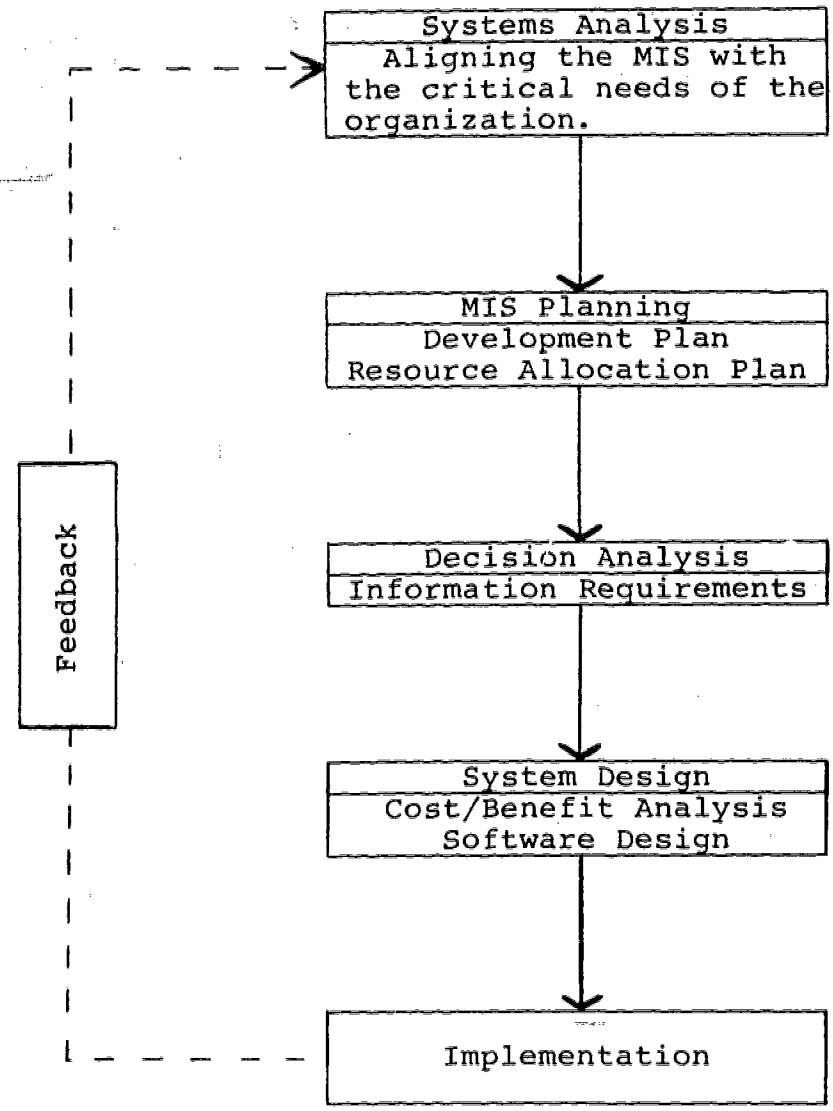


Figure 4

Framework for MIS Development

education must succeed. The computerized information system is then fashioned around these critical areas. The output of this systems analysis is a strategy that provides for the development of MIS plans specifying which projects to be developed and the resources required.

The next element in the framework is the detailed design, development, and implementation of the projects previously identified. Although identifying the set of decisions and the characteristics required to support them seems to be straightforward, unfortunately identifying such information needs can be very difficult. A wide range of approaches is possible. At one extreme, the user of the system is simply provided with whatever information is requested. At the other extreme the system's designer determines the information that is required and provides it to the user. Effective approaches to systems design obviously lie between these extremes.

After the specifications of a new system are developed, attention must then be turned to the detailed task of building and implementing the system. The main difficulties arise from the wide number of options available for providing the information with each option entailing different costs. Of course, information has different values as well. Information varies in terms of quality, timeliness, and accuracy. Each variable influences costs. The design of a system must be based on an efficient

allocation of resources among options so as to maximize benefits relative to costs.

Foundation of the Framework

The framework is based on a combination of philosophy and mechanics. The philosophy underlying the model is straightforward. To provide the maximum benefits, the MIS system must be based on an understanding of the goals of the vocational education system and the environment in which the system operates. In short, the information system must address the areas which are critical to the success of the system. The effect of this philosophy is to link the information system directly to the purpose of the vocational education program.

Conceivably, to maximize the benefits of the information system the development of certain so-called "obvious" computer projects such as payroll, accounting, and other bookkeeping systems may have to be ignored. Instead, projects that deal with projecting occupational openings, follow-up of graduates, and the design of a decision-making support system may be more critical to the success of the total vocational education program and as a result they should receive the highest priority.

A Strategy for Information Systems Development

Having isolated the subset of information system objectives within the larger set of the vocational education system objectives, it is necessary to develop a strategy or plan for achievement. The Planning-Programming-Budgeting System (PPBS) conceived for use in managing programs of an ongoing nature is appropriate. This approach provides a concrete method through which the objectives of the information system can be achieved. Since the information needs of vocational education are, no doubt, dynamic in nature, a formal planning system provides an ideal vehicle for incorporating the needs of the future into the design of the present.

It is important to note that the demands of planning and controlling an information system go beyond the scope of conventional planning systems. The difficulty of estimating benefits and the dynamic nature of information needs suggests that PPBS is a valuable planning approach. The value of PPBS stems from the fact that it focuses on the link between the objectives of the organization and the programs developed to implement them.

The Decision Making Process and Information System Design

The precept of the framework is that the information system must be designed on the basis of the needs of users. Obviously, the needs of users will vary according to the

nature of their tasks. Thus, the information system must represent different things to different users. Robert Anthony has proposed three levels in the planning and control process.[9] These levels are:

1. Strategic planning: which is the process of deciding on the objectives of the organization.
2. Administrative control: which is the process of assuring that resources are used effectively in the accomplishment of the organization's objectives.
3. Operational control: which is the process of assuring that specific tasks are carried out effectively and efficiently.

In turn, the characteristics of the information required to support each of these levels of planning and control are quite different. Information for strategic planning purposes involves the making of long-range estimates which are expected to be quite imprecise. Information for administrative planning should be more precise so that the user can explore a variety of relationships. Finally, information at the operational level such as enrollment, program costs, and follow-up should be accurate and timely. Recognizing these differences in the nature of the decision-making process provides guidelines to the development and design of the information system.

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[9]Robert N. Anthony, Planning and Control Systems: A Framework for Analysis (Boston: School of Business Administration, Harvard University, 1965) pp. 15-18.

Summary

The premise of this chapter was that the use of MIS systems in the planning of vocational education is a mirage. The point was made that the information typically provided by MIS systems is not the type of information needed by planners. The problem is attributed to a misunderstanding by administrators of the purpose of information systems in the planning and operation of vocational education programs. To exemplify this misunderstanding an analysis of the design and operation of the MIS system in Missouri was provided.

As a remedy to faulty design and operation a framework for MIS development was provided. The purpose of the framework is to provide the administrator with a structure that will aid in the development of MIS systems. The essence of the framework is that the design of MIS systems must be dictated by the goals of the vocational education system. In short, the information system must be designed to provide information on those areas that are critical to the success of the vocational education system.

CHAPTER IV

A DECISION-MAKING SUPPORT SYSTEM

The improvement of vocational education planning requires a willingness to change on the part of those responsible for the administration of vocational education. Historically, vocational education administrators have resisted change. However, the advent of MIS systems and quantitative approaches to decision making in vocational education by their very nature require change.

It has been demonstrated that MIS systems and quantitative analysis have had far reaching effects in improving the planning and operations of business, industry, and the military.[10] Given a chance, the same results can be achieved in the planning of vocational education if decision makers are willing to accept change.

In this chapter the development of a decision-making support system for vocational education is described. The essence of this system lies in the application of quantitative tools to the analysis of vocational education planning problems. In the chapters in Section II of this report, specific applications of the techniques are presented;

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[10]Forest W. Horton, Jr., Reference Guide to Advanced Management Methods (American Management Association, Inc., 1972), pp. 130-135.

therefore, this chapter is intended to provide an overview of the decision making support system.

The premise underlying the decision-making support system is that the nature of the problems to be solved or decisions to be made should dictate the anlytical technique to be used. The framework of the approach is presented in Figure 5 and consists of the following steps:

1. Define the system under study,
2. Define the measure of effectiveness,
3. Identify the analytical approach appropriate for the problem,
4. Construct a model of the system,
5. Generate alternatives, and
6. Decide on an alternative.

One of the more innovative aspects of this project was the development and application of the analytical techniques in step three above. These techniques were:

- Linear programming,
- Goal programming,
- Simulations,
- Statistical analysis,
- Heuristic models.

A brief explanation of these techniques follow.

Linear Programming

Linear programming is a mathematical technique that has been used for more than 20 years to solve complex

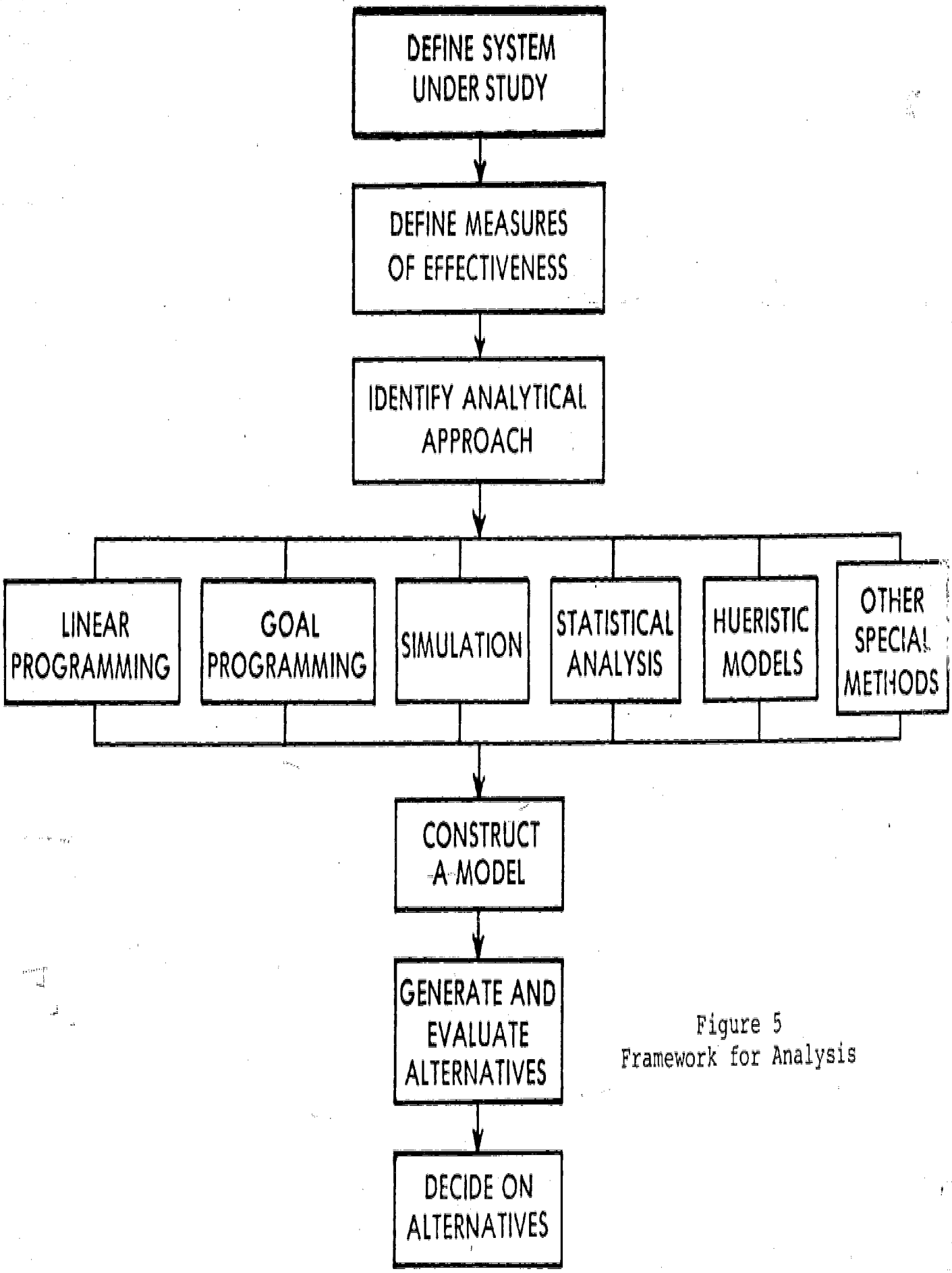

Figure 5
Framework for Analysis

resource allocation problems in business, government, and industry. The technique has been one of the most frequently and successfully applied mathematical approaches to decision-making.[11] The purpose in using linear programming is to develop a mathematical model of the system under study which aids the decision maker in determining the optimal allocation of the system's resources. Since the resources employed in an organization have an economic value and the available choices entail costs, the linear programming problem of most organizations is that of allocating scarce resources among choices so that benefits are maximized.

The first stage in demonstrating and applying the linear programming technique is the formulation of the linear programming model. Every linear programming model has an objective function, that is, something to be maximized or minimized. There is general agreement in business and industry that this objective is the maximization of profit. In vocational education, however, there are several objectives which the system may try to achieve. Objectives often cited in vocational education are the maximization of training-related placements, the minimization of the number of dropouts, and the maximization of the number of students served. Obviously, a vocational administrator may try to meet several such objectives at once. Unfortunately, the

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[11]Robert L. Childress, Sets, Matrices, and Linear Programming (New Jersey: Prentice-Hall, Inc., 1974), pp. 140-141.

linear programming technique does not allow the decision maker to consider more than one objective at a time. It is generally agreed, however, that the maximization of training-related placements is a most desirable goal, so this limitation does not necessarily pose a problem.

In addition to the objective function, a model of vocational education must include constraints. These are restrictions imposed upon the system. Examples of constraints that might be depicted in a system of vocational education include the following:

1. Projected occupational openings,
2. Availability of students,
3. Budget,
4. Disadvantaged students to be served,
5. Completers in the labor force,
6. The number of program completers, and
7. Students continuing education.

Once the linear programming model is formulated mathematically, it is then applied to the system under study. Once the model is applied, it can also be used by the decision maker to simulate changes in the system's environment. To do so, the value of the constraints in the model are changed and a new optimal solution is sought which accomplishes the objective of the vocational education system. By altering these constraints, the vocational education planner can explore the effect that different plans have

on the system. For the specific application of this technique to the planning of vocational education in Missouri refer to Chapter VI of Section II.

Goal Programming

Although the linear programming technique allows the decision maker to solve single objective problems, goal programming, in contrast, allows the decision maker to handle multiple objective problems.[12] Thus, goal programming is a more flexible technique since the decision maker can solve problems involving multiple goals. Obviously most vocational education systems pursue more than one goal simultaneously, so this technique is extremely valuable.

The first step in the application of the goal programming technique is the formulation of the model. The objective function, as developed, should reflect the multiple goals of the vocational education system. For example, in Missouri the following goals were expressed by leaders of vocational education:

- Limit the number of trained students in a vocational program to the projected job openings.
- Increase vocational enrollments to fifty percent of secondary 11th and 12th grade students.
- Limit the expenditure on vocational education programs to the resources available.

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[12]Edward R. Clayton and Sang M. Lee, "A Goal Programming Model for Academic Resource Allocation", Management Science, XVIII, No. 8, (April, 1972), pp. 395-408.

- Increase the number of disadvantaged students served by ten percent over the previous year.
- Increase the number of program completers placed in training-related occupations by 10 percent.
- Increase the labor force participation of vocational education graduates by 15 percent.
- Increase the number of program completers to 24,000 students.
- Increase the number of program completers continuing their education by 10 percent.

The model that reflected these goals was applied and a program mix that maximized their accomplishment was found. In addition, the model was used to simulate changes in the decision-making environment by allowing the decision maker to ask a series of "what if" questions. These questions were answered by either changing the priorities assigned to each goal or manipulating the constraints in the environment. The goal programming technique, as applied to program planning in Missouri, is presented in more detail in Chapter VII of Section II.

Simulation

Simulation can be used to derive solutions when analytic and numerical methods break down or are impractical to employ. When the relationship among variables cannot be determined empirically, simulation is ideal[13] (Figure 6).

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[13]Joe H. Mize and J. Grady Cox, Essentials of Simulation. (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1969) pp. 2-33.

INPUTS AND OUTPUTS ASSOCIATED WITH A VOCATIONAL EDUCATION SYSTEM SIMULATION MODEL

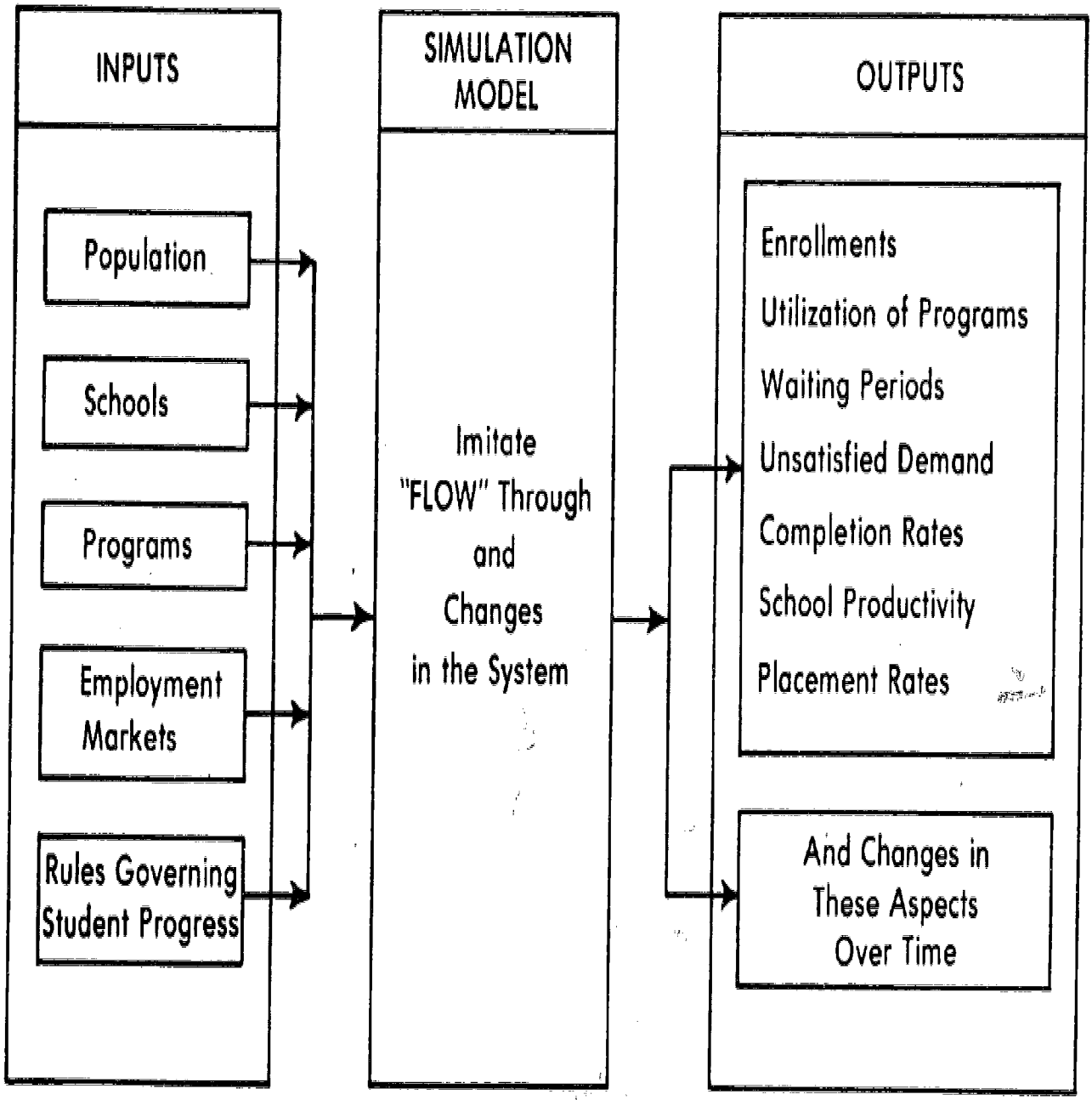

Figure 6

To avoid becoming too technical, the following is a scenario of the type of situations where simulations are useful. The vocational education system involves the "flow" of individuals through a sequence of steps: the decision to pursue vocational training, selection of a school and program, completion of the program, and subsequent employment. At each step one of several decisions can be made and the choice may be based on several factors.

Simulation methods were conceived and developed precisely to cope with systems having these characteristics. Indeed, simulation models consist essentially of descriptions of system components and their characteristics and of the rules governing selection among alternative next steps. Naturally, these rules usually involve uncertainty; for example: The chances that a St. Louis area school welding trainee will find immediate local employment in the construction industry are from 40% to 90%, depending on the time of year and the growth rate of the local aircraft manufacturing idustry. An effective simulation model would allow detailed specification of such characteristics and dependencies and would then mimic (with the aid of a computer) the progress of a large number of students who would come from the populations described, enter the available schools and programs, terminate or change programs, or enter some employment market upon program completion. All of this occurs according to specified rules. Once the model has been sufficiently tested and refined to the point where planners can accept

its results as reasonable and meaningful, the system's designers or decision makers can make arbitrary changes in system components and use the model to assess the likely effects.

Thus, we are led to consider the nature of the inputs and outputs of an appropriate simulation model. That is, the information which should be provided to obtain a satisfactory simulation, and the corresponding results which simulation can provide for management review. The inputs are essentially of two kinds: (1) information describing the components of the vocational education system and (2) information describing the "rules" controlling student progress through the system. The inputs listed in Figure 6 are simply suggestive. The simulation can be configured to collect information on virtually any aspect of system operations included in a logical/descriptive model. The outputs suggested are examples of the types of information vocational education system planners are likely to want to consider. Such information can be organized and displayed in a large number of ways. For example, average values and proportions, median information, and sample variance might be of concern. Thus, planners might choose to simulate several different systems over a span of five years and have operations summarized quarterly, semiannually, or annually for purposes of comparison. Thus, they could assess the likely effects of adding new schools, expanding program offerings, etc.

The potential use of simulation extends far beyond this simple description and should be an integral tool in a decision-making support system for vocational education.

Statistical Methods

The use of univariate statistical methods, such as regression and analysis of variance, in problems involving the planning of vocational education are not new. They are not dealt with in this brief description, although their importance remains. This report, instead, describes some of the uses and potential of multivariate statistics in vocational education planning.

Multivariate analysis can be characterized as all those statistical methods which simultaneously analyze more than two variables on a sample of observations.[14] One way of classifying multivariate techniques is on the basis of the number of sets of variables and populations addressed by that specific technique (Figure 7). All of the techniques in the first quadrant are interdependence models while those in quandrants 2, 3, and 4 are techniques for the analysis of dependence. In the former case, the purpose is to give form or meaning to a data set while the latter techniques are designed to explain or predict a variable from another set of variables.

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[14]Maurice M. Tatsuoka, Multivariate Analysis (New York: John Wiley & Sons, Inc., 1971), pp. 217-225.

CLASSIFICATION OF MULTIVARIATE PROCEDURES

VARIABLES	POPULATIONS	
	ONE	TWO OR MORE
ONE SET	Principal Components Factor Analysis Cluster Analysis Q1	Multivariate Analysis of Variance Discriminant Analysis and Classification Q2
TWO OR MORE	Q3 Multiple Regression Canonical Correlation	Q4 Multivariate Analysis of Covariance

Figure 7

The benefits of these techniques rest in their ability to allow the planner to deal with multiple independent variables and multiple dependent variables simultaneously. Obviously, planning problems in vocational education demand the consideration of multiple dependent as well as multiple independent variables. In this project, many uses were made of multivariate statistics. In one case, principal components analysis and canonical correlation were used in the development of a multivariate model for measuring vocational education program effectiveness. In another situation, factor analysis and multiple discriminant analysis were used to modify employment projections used for program planning. The techniques made it possible to classify occupations on the basis of required entry skill levels and thus gain a great deal of additional information about the profile of projected occupational openings. These examples only suggest a few of the many possible applications of multivariate statistics to vocational education planning. The possible applications, no doubt, are a function of the researcher's genius.

Heuristic Methods

Heuristic methods and models definitely have a respectable place in analytic methodology. There are many problems in vocational education planning that are extremely difficult to approach mathematically. Yet, decision must be made. The term heuristic, as commonly used, refers to the

use by the administrator of a rigorous set of rules or guides to decision making. The process may not necessarily be optimal, but if it is applied consistently, it is efficient, and avoids a lot of complicated problem solving.

No doubt such so-called rules of thumb, or heuristics, are used in vocational education planning rather extensively. A valid criticism against vocational planning is not that this approach is used extensively, but rather that the rules that guide decisions are not developed in a logical or consistent manner. Given these considerations, we sought to illustrate the development of a heuristic model that focuses on a very basic problem in planning vocational education programs; that is, determining the number of people who need vocational education services.

The methodology is described in Chapter IX of Section II. It presents for planning purposes, a standardized technique for estimating the need for vocational education services in Missouri. The methodology differentiates those in need of vocational education by secondary, post-secondary, and adult levels. The technique makes use of current employment service data on area unemployment. In addition, population, labor force, and income data from the decennial census updated on the basis of current relationships developed from national labor force and poverty data are used. The technique is applicable at either the state, regional, or local level. It provides an unbiased estimate of those in need of vocational education services. One of the

primary strengths of the technique is that given the same data base, different planners would arrive at the same estimate of need. In short, the estimate of need reached through the application of the approach is verifiable.

Conclusion

There are many other tools and techniques that are useful in planning vocational education programs that would logically be a part of a decision-making support system. Tools such as network planning systems, cost-benefit analysis, PPBS, and many others are useful. This study, however, has focused on those tools that have great potential in planning vocational education but have generally not been available to the vocational education decision maker. In Section II examples of the application of each of these techniques are presented.

CHAPTER V

AN EVALUATION SYSTEM

The literature on educational evaluation is distressingly repetitious. In reading the literature dealing with vocational education evaluation, one is bombarded with repeated explanations about how evaluation can be distinguished as either processes, products, or programs, or how evaluation should serve decision makers. It seems that every writer on vocational education evaluation feels a necessity to climb (or descend) the evolutionary ladder. Often it seems as if the scholarly work that has been done before is largely ignored.

This report on evaluation seeks to break the cycle. First, it is recognized that there are many scholarly works on evaluation, and it is suggested that vocational education administrators make use of them. Secondly, it seems unnecessary to extol the virtues of evaluation. Instead we assume that the vocational education administrator either recognizes the need for evaluation or wants nothing to do with it. For those who believe in evaluation, a system that meets the need for a state level vocational education evaluation model is described. The evaluation system as develped is based on the premises that:

1. The needs to be met by vocational education are not constant over time and will vary for different target groups.
2. There is more than one measure of the effectiveness of vocational education.
3. The measures of effectiveness should reflect the goals of the system.
4. The evaluation system should provide direction--in other words, be prescriptive.

Given these considerations, the following system was developed. The starting point of the evaluation system is the identification of the system's goals. Next, measures of effectiveness that reflect the goals are identified. Then a mathematical model based on the goals of the vocational education system as well as the constraints on the system is formulated. The model is then applied. The solution that results from the application of the model depicts the optimal vocational education system, given the goals and constraints of the system. After the optimal system is found, specific changes or recommendations are made to calibrate the existing system with the optimal system. This information then becomes feedback to the planner for appropriate action. These steps are depicted schematically in Figure 8.

Application of the Evaluation Model in Missouri

In this section an application of the vocational education model in Missouri is described. As indicated, the starting point of the model is the identification of goals.

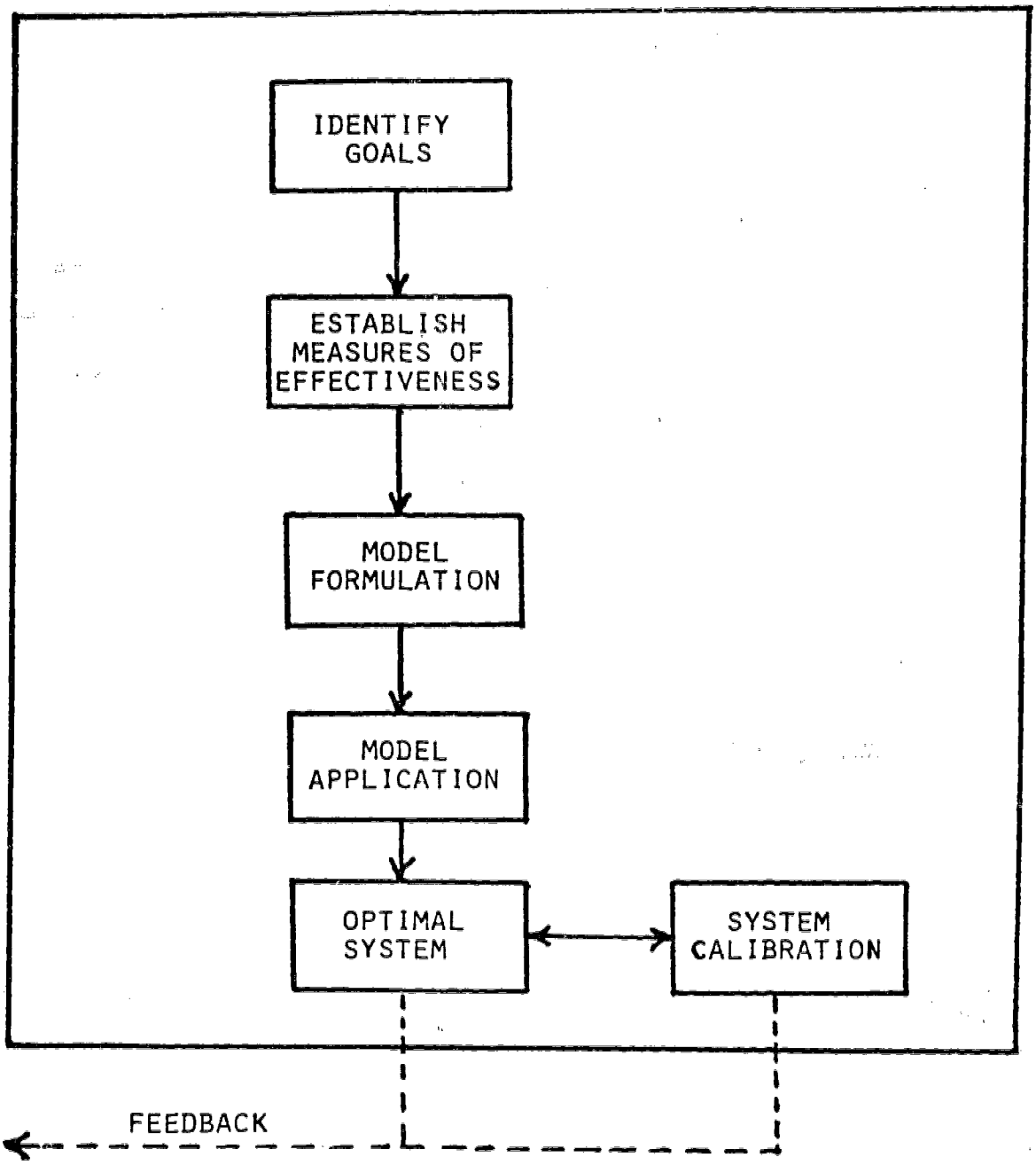

Figure 8

Vocational Education System Evaluation Model

Vocational education leaders in Missouri ranked and ordered the goals of vocational education as:

1. Increase the placement of completers in training-related jobs.
2. Increase the participation of program completers in the labor force.
3. Increase the total number of completers served by vocational education programs.
4. Increase the number of students continuing their education after completing a vocational education program.

In turn, measure of effectiveness that reflected these goals were established. The next step was to formulate a mathematical model based on the goals and constraints of Missouri's vocational education system.

With these tasks completed, the model was then applied. The solution depicted an optimal program mix of offerings, completions, and enrollments. This so-called optimal system represents a vocational education delivery system which maximizes the accomplishment of the goals of vocational education in Missouri.

The solution to the model represents what might best be described as a theoretically ideal mix of programs. The deviation of the existing system from this ideal solution indicates the extent to which the vocational education system is not meeting the goals of the system. To measure the relationship between the existing program mix and the optimal program mix a correlation coefficient was computed. A correlation of .59 was found. This coefficient indicated that the existing mix of programs and the idealized mix are

substantially different. There are several possible explanations for these differences:

1. There is a difference between the expressed goals and the actual goals at the state level. Thus, the formulation of the model is not correct.
2. The vocational education system in Missouri is not effective in accomplishing its goals.
3. There is a difference between the goals pursued by local program administrators and those pursued at the state level.

Whatever the explanation might be,[15] if the vocational education administration at the state level desires to achieve the expressed ideal mix of programs, certain changes need to be made. Specifically, the administrator needs information regarding which programs to change. The following tables (Tables 1, 2, 3) present recommended changes. This step as presented in the evaluation model is appropriately known as system calibration.

By implementing the proposed program changes the correlation between the idealized mix and the existing mix of programs would be .98. That is, there would be a near perfect match between the idealized program mix and the actual program mix in Missouri. It is in this context that the proposed program changes become feedback to those responsible for administering the vocational education system.

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[15] Ascertaining the reasons for the discrepancy is important. The planner should make every effort fo find causes for any discrepancies that occur.

TABLE I

RECOMMENDED CHANGES IN THE COMPLETIONS OF GRADUATES
FROM THE EXISTING PROGRAM MIX IN MISSOURI

Program	Action	Amount of Change	Current Level
Production Agriculture	increase	900	1540
Agriculture Supplies & Services	decrease	200	267
Agriculture Mechanics	decrease	2250	2294
Automotive Distribution	increase	300	172
Food Distribution	increase	400	400
Food Service	decrease	550	582
General Merchandise	decrease	150	281
Hardware & Bldg. Materials	increase	400	158
Home Furnishings	increase	80	45
Petroleum	decrease	60	113
Transportation Occupations	increase	1500	34
Practical Nursing	increase	340	233
Health Occupations	increase	250	34
Accounting & Computing	increase	2500	1242
Office Machines	decrease	900	1033
Air Conditioning	decrease	100	164
Electrical Appliance Repaimen	increase	85	37
Auto Body	decrease	300	398
Auto Mechanics	decrease	400	1017
Carpentry	decrease	225	858
Electricity	increase	220	77
Plumbing & Pipefitting	increase	130	32
Drafting	decrease	150	222
Electronic Occupations	decrease	200	266
Foremanship, Supervisor & Management Development	increase	1000	25
Quantity Food Occupations	decrease	180	254
Textile Fabrication	increase	600	56
Trade and Industry	increase	416	25

TABLE 2

VOCATIONAL PROGRAMS TO DROP

Program	Completions Previous Year	Program	Completions Previous Year
Agriculture Products	40	Messenger Boy Service	26
Ornamental Horticulture	146	Shipping & Receiving	10
Agriculture Forestry	74	Automotive Technology	88
Finance & Credit	78	Civil Technology	24
Industrial Marketing	42	Data Processing	383
Insurance	10	Police Technology	13
Personal Services	115	Custodial Service	68
Real Estate	335	Diesel Mechanic	61
Nurses Aid	548	Instrument Repair	20
Radiologic Technician	7	Refrigeration	119
Occupational Home Eco.- All Programs	469	Small Engine Repair	255

TABLE 3

VOCATIONAL PROGRAMS TO ADD

Program	Number of Completions
Mail - Postal Clerks	380
Information Communication Occupations	325
Electrical Appliance Repair	85
Aircraft Maintenance	47
Painting & Decorating	300
Stationary Energy Sources	200

Conclusion

It is of course realized that vocational education administrators would not make extensive or indiscriminate program changes based on such information without additional analysis. Rather, the recommended program changes serve as signals regarding programs that may need further monitoring or more evaluation. In some cases, the evaluative information may be such that immediate change is required. In other cases the change may need to be long range.

Clearly, the state level evaluation system provides the decision maker with evaluative information that reflects the extent to which the stated goals of the vocational education delivery system are being met. And even more, it provides prescriptive information regarding program changes that would bring the system more closely in line with its expressed goals. By applying this system repetitively, the strengths and weaknesses of the vocational education system would become clear and the impact of changes that are made would be discernible. This type of system has the potential for greatly enhancing the effectiveness of the state level decision maker.

SECTION I SUMMARY:

THE PLANNING MODEL

In this section the background for the development of a model for planning vocational education was described. The model and its components were presented. The difference between administrative planning and strategic planning was clarified. An analysis was made of MIS systems as they currently exist in Missouri and other states and specific recommendations were made regarding ways the performance of such systems can be improved. In turn, a decision-making support system was explained along with the analytical techniques that comprise the support system. Finally, an evaluation model for vocational education was depicted along with an example of the system's use in Missouri.

Although it may not be obvious, the planning model described in this section was designed specifically to provide Missouri's vocational education study group, Task Force 1990, with a rational and an empirical means of answering questions that arose in the course of their investigation. Accordingly, the plan for vocational education in Missouri through the year 1990. A copy of the operational plan is presented in Appendix II. The reader is encouraged to examine this plan so as to gain an understanding of the application of the planning model in the development of a plan in Missouri.

SECTION II

APPLICATION OF THE DECISION MAKING SUPPORT SYSTEM

OVERVIEW OF SECTION II

The chapters in this section present detailed examples of the application of the decision-making support system to the planning of vocational education in Missouri. To illustrate every application that was made of each technique would surely belabor the topic and add little to the report. Therefore, it is important to recognize that several applications have not been included. However, the most innovative applications are presented. There is one exception that needs clarification. An example of the application of the simulation technique is not included because the simulation model has not been refined to the point where the reserach team is satisfied with its applicability. After further testing and refining of the simulation system the results will be shared with the U.S.O.E. and the profession at large.

CHAPTER VI

THE DECISION MAKING SUPPORT SYSTEM: LINEAR PROGRAMMING APPLICATION

In discussing linear programming there are two steps which are particularly relevant to one's understanding of the use of the technique. The first is the formulation of the model and the second is the application of the model to decision making. Each step is presented in this chapter.

Formulation of the Linear Programming Model

As a prelude to the formulation of the linear programming model, several factors were considered. For one, to be useful, the model had to reflect the complexity of Missouri's system of vocational education. An effective model should have the following: a valid objective function, choice variables which can be manipulated, and constraints which depict the environment of vocational education. Second, the model should contain only one objective. In this application that objective was to maximize the number of completers placed in training-related occupations.

The Objective Function

Every linear programming model has an objective function, that is, something which is to be maximized or minimized. There is general agreement in business and

industry that this objective is the maximization of profit. In vocational education, however, there are several objectives which the system may attempt to achieve. Objectives often cited are the maximization of training-related placements, the maximization of the number of students pursuing higher levels of education, the minimization of the number of dropouts, and the maximization of the number of students served. Obviously, a vocational administrator may try to meet several of these objectives simultaneously. Unfortunately, the linear programming technique does not allow the decision maker to consider more than one objective at a time.

Members of the Task Force 1990 presented an argument for using training-related placements as the primary measure of vocational education effectiveness. The rationale for this measure was straight-forward. Investments are made in vocational education by the federal government on the basis that vocational education can help meet the manpower needs of society. The states then, through contractural arrangements, agree to this goal. If the programs that are established train students in occupations for which there is not a manpower need, then these students will have difficulty in securing employment in the occupation. On the other hand, if there is a manpower need, employment opportunities should exist and placement rates should be high. Thus, program placement rates are judged to be reliable measures of program effectiveness.

Mathematically, the goal of maximizing training-related placements was represented as:

$$\text{Maximize:} \quad Z = \sum_{j=1}^{N} P_j X_j \qquad (1.1)$$

where Z is the number of graduates placed in training-related occupations, X_j is the number of completers of occupational program j, and P_j is the percent of completers in the state that found employment in occupation j in the past.

The choice variables (X_j) in the above equation are the number of completers of each program. There are several ways these variables can be controlled. The number of completers can be adjusted (manipulated) by raising completion standards, by discouraging or limiting the number of enrollees, or by presenting information to students on employment. It may be argued that such manipulation is inconsistent with democratic ideals of freedom of choice. This, of course, must be balanced against the injustice that can occur when students are trained in occupations where there are limited employment opportunities and the school system, either on purpose or by neglect, leads students to believe otherwise.

The Constraints

Constraints, in linear programming, are restrictions imposed on the system as attempts are made to maximize the output reflected in the objective function. Constraints that might be imposed on Missouri's system of vocational

education include funds available, projected occupational openings, number of interested students, entry level wages, and the number of disadvantaged and handicapped students to be served. The more constraints, the more complex the decision-making environment becomes. Mathematically, the constraints on the Missouri system of vocational education were represented as follows:

A. Projected Occupational Openings

$$A_j X_j \leq PO_j \quad (j=1 \ldots n) \tag{1.2}$$

where PO_j is equal to the projected occupational openings for vocational program j in the state. A_j is the inverse of the fractional equivalent of the percent of the projected openings for that occupation which have been met by vocational education in the past. As an example, if 50 percent of the welders in the state have been trained in vocational programs, then the fractional equivalent is $\frac{50}{100}$, which inverted, becomes $\frac{100}{50} = 2$. If vocational education is assumed to be the sole training source, then this coefficient is 1. As before, the choice variables are X_j's which are the program completers.

B. Number of Students Available

$$\sum_{j=1}^{N} L_j X_j \leq PE \tag{1.3}$$

Here, PE is equal to 50 percent of the projected enrollment of students in grades 11-12 in the state. X_j is equal to

the completers of program j and L_j is the length of the program in terms of years. This constraint was necessary because the number of students enrolled in vocational education cannot exceed those enrolled in secondary education in the state.

C. Budget

$$\sum_{j=1}^{N} C_j X_j \leq B \qquad (1.4)$$

Obviously, more dollars cannot be spent on vocational education than are available. In the above inequality B is equal to the budget constraint for the state and X_j is equal to the completers of occupational program j in the state. The C_j is equal to the cost of educating each program completer in occupational program j.

D. Disadvantaged

$$\sum_{j=1}^{N} D_j X_j \geq DIS \qquad (1.5)$$

State boards of vocational education are required by federal law to spend at least 15 percent of federal money on the disadvantaged. Assuming that the cost of serving the disadvantaged is the same as those that are not disadvantaged and that the state and local matching support for disadvantaged students is in the same proportion as for regular students, then at least 15 percent of vocational enrollment should be individuals classified as disadvantaged.

The mathematical formula for this constraint is composed of the following terms: The X_j is as before, the completers of program j in the state. The DIS is equal to 15 percent of the projected vocational completions for the state. The D_j values are the percent of completers from program j, based on historical data, who have been disadvantaged.

E. Training-related Placements[16]

$$\sum_{j=1}^{N} P_j X_j \geq TR \qquad (1.6)$$

In this constraint the P_j values are the placement rates derived from historical data for every program in the state. The X_j values are the number of completers of each program j. The TR is the total of completers placed in training-related jobs from the previous year increased by 10 percent. For 1976 this constraint was 8,065. This constraint guarantees that the solution to the linear programming problem will increase the number of completers placed in training-related jobs by 10 percent.

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[16]This constraint equation, in fact, is a repetition of the objective function; the reason for including it in the model is to facilitate the comparison of the linear programming model with the goal programming model which is described in a later section.

F. Completers in the Labor Force

$$\sum_{j=1}^{N} LFPR_j \; X_j \geq LFP \qquad (1.7)$$

This constraint limits the solution to the problem, in that the labor force participation of completers must be greater than the labor force participation of completers from the previous year. This constraint was set at 13,689 for 1976, which was a 10 percent increase over the previous year. In the equation, the coefficient ($LFPR_j$) equals the labor force participation rate of completers from each program.

G. The Number of Program Completers

$$\sum_{j=1}^{N} X_j \geq C \qquad (1.8)$$

This equation forces the solution to meet a certain number of completers. The C was set equal to 24,446 students which was a 10 percent increase in the number of completers over the previous year.

H. Students Continuing Education

$$\sum_{j=1}^{N} BS_j \; X_j \leq CE \qquad (1.9)$$

This constraint equation was used to establish an upper level for the number of completers who continue their

education and was assigned the value of 5,767 which was a 10 percent increase over the previous year. Logically, this constraint equation could be formulated to include a lower limit, that is, be formulated to be equal to or greater than a specified level. This was not done in this formulation.

These BS_j coefficients are derived by computing the percent of completers from each program who have gone on to higher education rather than entering the labor market.

The Complete Model

By combining the objective function and the constraint equations the complete model is represented as:

$$\text{Max } Z = \sum_{j=1}^{N} P_j X_j \qquad (1.1)$$

subject to:

$$A_j X_j \leq PO_j \quad (j=1 \ldots n) \qquad (1.2)$$

$$\sum_{j=1}^{N} L_j X_j \leq PE \qquad (1.3)$$

$$\sum_{j=1}^{N} C_j X_j \leq B \qquad (1.4)$$

$$\sum_{j=1}^{N} D_j X_j \geq DIS \qquad (1.5)$$

$$\sum_{j=1}^{N} P_j X_j \geq TR \qquad (1.6)$$

$$\sum_{j=1}^{N} LFPR_j X_j \geq LFP \qquad (1.7)$$

$$\sum_{j=1}^{N} X_j \geq C \qquad (1.8)$$

$$\sum_{j=1}^{N} BS_j X_j \leq CE \qquad (1.9)$$

$$X_j \geq 0 \quad (j=1 \ldots n)$$

Application of the Model to the Missouri System

In this section the application of the linear programming technique is demonstrated by solving the linear programming model as formulated in the previous section. Once this model was applied, sensitivity analysis was conducted by changing the values of some of the constraints in the model. In total, three linear programming problems were solved and the results of each are presented to illustrate the flexibility of the technique as a tool to support the vocational education decision maker.

The Initial Application: Maximization of Training-Related Placements

The objective function of the model was the maximization of the number of training-related placements. When the model was applied, given this objective, the mix of programs that resulted from the application was found to place 9113 students in training-related occupations. The distribution of completers that resulted is presented in Table 4.

TABLE 4

DISTRIBUTION OF COMPLETIONS BY PROGRAM AREA:
INITIAL APPLICATION

OE Program	Number of Completions	Projected Openings
Agriculture Services & Supplies	23	23
Agriculture Mechanics	44	112
Production Agriculture	2504	2504
Advertising Services	21	21
Apparel and Accessories	510	583
Automotive	476	476
Floristry	23	23
Food Distribution	833	1048
Food Service	35	35
General Merchandise	148	148
Hardware, Bldg. Materials, Farm & Garden Supplies and Equipment	516	516
Home Furnishings	124	124
Petroleum	56	56
Recreation and Tourism, Other	11	11
Transportation	1537	1537
Miscellaneous Distribution	401	401
Dental Assistant	68	68
Practical Nursing	700	700
Radiologic Technician	55	55
Health Occupations, Other	281	426
Accounting and Computing	3759	3759
Business Data Processing System Occupations	321	321
Filing, Office Machines & General Office Clerical Help	530	530
Mail & Postal Clerks	381	381
Information Communication Occupations, Other	326	326
Stenographic, Secretarial & Related Office Occupations	2867	2928
Typing	960	1036
Office Occupations, Other	476	544
Electrical Technology	41	41
Commercial Pilot Training	11	11
Miscellaneous Technical Education, Other	12	12
Air Conditioning	68	68
Electrical Appliances	86	86
Auto Body	109	209
Auto Mechanics	671	811

(continued)

TABLE 4 - Continued

OE Program	Number of Completions	Projected Openings
Aircraft Maintenance	48	48
Business Machine Maintenance	17	62
Commercial Art Occupations	33	33
Carpentry	634	634
Electricity	265	265
Masonry	40	40
Painting and Decorating	309	309
Plumbing and Pipefitting	169	169
Roofing	11	11
Construction & Maintenance Trades, Other	119	119
Drafting	95	95
Electrical Occupations	81	81
Electronic Occupations	207	207
Graphic Arts Occupations	249	249
Metalworking	865	865
Barbering	256	256
Cosmetology	707	707
Public Service Occupations, Other	12	72
Quantity Food Occupations	68	68
Stationary Energy Sources	202	202
Textile Production and Fabrications	789	789
Leatherworking	293	293
Trade and Industry, Other	416	416
Foremanship, Supervisor and Management Development	1066	1066
Woodworking	148	148

In addition the final level of each constraint is presented in Table 5. Table 5 presents the deviation from each constraint. The limiting factor to this solution was the budget constraint. If more funds had been available then the number of completions would be larger, more projected

job openings filled, and more students placed in training-related occupations.[17]

TABLE 5

FINAL VALUE OF CONSTRAINTS: INITIAL APPLICATION

Constraint	Value	Deviation From Constraint
Availability of students	57,309	-24,212
Budget	75,727,550	0
Labor Force Participants	13,469	-220
Completions	26,083	+1,637
Students Continuing Education	5,129	-628
Disadvantaged	2,668	-932
Projected Job Openings	26,083	-939

The mix of programs presented in Table 4 maximizes the number of program completions in training-related employment given the system's constraints. If the decision maker prefers to maximize the placement of completers in training-related occupations, then this mix of program completions should be implemented. The program planner, based on differences between the existing program mix and the program mix resulting from the linear programming application, could recommend program expansion or contraction so that the number of completions in training-related employment was, in fact, maximized.

[17]The projected job openings constraint depicted in Table 5 represents a summation of openings for all occupational areas. Reporting projected openings as one constraint, rather than as a separate constraint for each occupation, may tend to conceal the fact that several of the program areas are constrained by projected openings and should not be increased in size, relative to the number of completions, even if funds are available.

Simulating the Effect of Changes in the Vocational Education System's Environment

The usefulness of the linear programming technique extends beyond the initial application just presented. The technique allows the decision maker to simulate the effect of changes in the system's environment. To do so, the value of the constraints in the model are changed and a new optimal solution is sought which accomplishes the same objective as before: the maximization of training-related placements. To demonstrate the use of the technique in simulating changes in the environment, two changes were made in the initial model. In the first change, the funds available were increased by $10 million. In the second change, the projected number of job openings for each vocational program area were increased. After making these changes, the model was applied and the solutions derived.

Second Application: Increasing the Resources Available

In the second application of the linear programming model, the funds to be spent on vocational education programs were increased by ten million dollars to $85,727,550. After making this change, the linear programming model was applied and a new optimal solution was found. The number of students placed in training-related employment increased to 9,451; of course, this is as expected because with more resources more students can be trained. In Table 6 the final value of each constraint is presented. From this table it can be observed

TABLE 6

FINAL VALUE OF CONSTRAINTS

Constraint	Value	Deviation
Availability of Students	58,535	-23,086
Budget	78,525,550	-7,202,000
Labor Force Participants	14,306	+437
Completions	27,022	+2,576
Students Continuing Education	5,146	-611
Disadvantaged	2,734	-866
Projected Job Openings*	27,022	0

*The projected job openings constraint, as presented in Table 6, is in fact a summartion of all projected occupational openings in occupations for which vocational education is appropriate.

that the limiting factor was the number of projected job openings for each program area. Accordingly, not all of the additional funds were allocated; inasmuch as over seven million dollars remained to be spent. The distribution of program completions from this application is presented in Table 7.

From this application the decision maker can "gleam" the following. For one, given the increased funds the decision maker is able to ascertain the effect these additional funds will have on the objective of maximizing training related placements. Moreover, information is now available to identify needed program expansion or contractions, given the additional funds.

In this particular application, however, the additional funds had a small effect on increasing training-related placements because the projected job openings constrained the optimal solution; that is, completions were not allowed to exceed the projected job openings. In the

TABLE 7

DISTRIBUTION OF COMPLETIONS BY PROGRAM AREA:
SECOND APPLICATION
(Budget Increased by $10 Million)

OE Program	Number of Completions	Projected Openings
Agriculture Services & Supplies	23	23
Agriculture Mechanics	112	112
Production Agriculture	2504	2504
Advertising Services	21	21
Apparel and Accessories	583	583
Automotive	476	476
Floristry	23	23
Food Distribution	1048	1048
Food Service	35	35
General Merchandise	148	148
Hardware, Bldg. Materials, Farm & Garden Supplies and Equipment	516	516
Home Furnishings	124	124
Petroleum	56	56
Recreation and Tourism, Other	11	11
Transportation	1537	1537
Miscellaneous Distribution	401	401
Dental Assistant	68	68
Practical Nursing	700	700
Radiologic Technician	55	55
Health Occupations, Other	426	426
Accounting and Computing	3759	3759
Business Data Processing System Occupations	321	321
Filing, Office Machines & General Office Clerical Help	530	530
Mail & Postal Clerks	381	381
Information Communication Occupations, Other	326	326
Stenographic, Secretarial & Related Office Occupations	2928	2928
Typing	1036	1036
Office Occupations, Other	544	544
Electrical Technology	41	41
Commercial Pilot Training	11	11
Miscellaneous Technical Education, Other	12	12
Air Conditioning	68	68
Electrical Appliances	86	86
Auto Body	209	209
Auto Mechanics	811	811

(continued)

TABLE 7 - Continued

OE Program	Number of Completions	Projected Openings
Aircraft Maintenance	48	48
Business Machine Maintenance	62	62
Commercial Art Occupations	33	33
Carpentry	634	634
Electricity	265	265
Masonry	40	40
Painting and Decorating	309	309
Plumbing and Pipefitting	169	169
Roofing	11	11
Construction & Maintenance Trades, Other	119	119
Drafting	95	95
Electrical Occupations	81	81
Electronic Occupations	207	207
Graphic Arts Occupations	249	249
Metalworking	965	865
Barbering	256	256
Cosmetology	707	707
Public Service Occupations, Other	72	72
Quantity Food Occupations	68	68
Stationary Energy Sources	202	202
Textile Production and Fabrications	789	789
Leatherworking	293	293
Trade and Industry, Other	416	416
Foremanship, Supervisor and Management Development	1066	1066
Woodworking	148	148

third application of the model the projected job openings constraint was removed; thus allowing the decision maker to allocate the resources regardless of the job openings constraint.

Third Application: Increase in the Projected Job Openings for Each Program

In this application of the linear programming model the projected occupational openings for each program were increased by 100 percent. Funds available for vocational education were increased by 10 million as in the second application. When the model was applied and the solution was determined, the number of completers placed in training-related occupations increased to 14,015. The final value of each constraint is presented in Table 8. The limiting factor in this application of the model was the funds available, since the projected job openings were no longer a constraint. This distribution of completions is presented in Table 9.

Additional Analysis

In the linear programming model formulated above, the objective was to find a mix of vocational programs which maximized training-related placements. As was demonstrated, the decision maker can simulate the effects of changes in the system's environment by changing the funds available or the projected job opening.

In addition to using the model to simulate changes in the environment, the linear programming technique provides the decision maker with the ability to do post-optimal sensitivity analysis. In other words, after the initial solution is reached, post-optimal analysis can be performed to find out the sensitivity of the number of training-related placement to changes in the contribution rate (placement rate of each program area). The contribution rates are represented by the P_j values in the equation below:

$$\text{Max } Z = \sum_{j=1}^{N} P_j X_j$$

TABLE 8

FINAL VALUE OF CONSTRAINTS

Constraint	Value	Deviation
Projected Job Openings	36,932	+9,910
Availability of Students	73,864	-7,657
Budget	85,727,550	0
Labor Force Participants	20,000	+6,311
Completions	36,932	+12,486
Students Continuing Education	6,023	+266
Disadvantaged	4,407	+407

TABLE 9

DISTRIBUTION OF COMPLETIONS BY PROGRAM AREA:
THIRD APPLICATION

OE Program	Number of Completions	Projected Openings
Agriculture Services & Supplies	0	23
Agriculture Mechanics	0	112
Production Agriculture	0	2504
Advertising Services	42	21
Apparel and Accessories	1020	583
Automotive	952	476
Floristry	46	23
Food Distribution	1666	1048
Food Service	70	35
General Merchandise	296	148
Hardware, Bldg. Materials, Farm & Garden Supplies and Equipment	1032	516
Home Furnishings	248	124
Petroleum	112	56
Recreation and Tourism, Other	22	11
Transportation	3073	1537
Miscellaneous Distribution	802	401
Dental Assistant	136	68
Practical Nursing	1400	700
Radiologic Technician	0	55
Health Occupations, Other	562	426
Accounting and Computing	0	3759
Business Data Processing System Occupations	316	321
Filing, Office Machines & General Office Clerical Help	1060	530
Mail & Postal Clerks	761	381
Information Communication Occupations, Other	651	326
Stenographic, Secretarial & Related Office Occupations	5733	2928
Typing	1919	1036
Office Occupations, Other	946	544
Electrical Technology	82	41
Commercial Pilot Training	22	11
Miscellaneous Technical Education, Other	24	12
Air Conditioning	136	68
Electrical Appliances	172	86
Auto Body	218	209
Auto Mechanics	1342	811

(continued)

TABLE 9 - Continued

OE Program	Number of Completions	Projected Openings
Aircraft Maintenance	96	48
Business Machine Maintenance	34	62
Commercial Art Occupations	66	33
Carpentry	1268	634
Electricity	530	265
Masonry	80	40
Painting and Decorating	618	309
Plumbing and Pipefitting	338	169
Roofing	22	11
Construction & Maintenance Trades, Other	238	119
Drafting	190	95
Electrical Occupations	162	81
Electronic Occupations	414	207
Graphic Arts Occupations	497	249
Metalworking	1730	865
Barbering	512	256
Cosmetology	1414	707
Public Service Occupations, Other	72	72
Quantity Food Occupations	0	68
Stationary Energy Sources	404	202
Textile Production and Fabrications	1578	789
Leatherworking	586	293
Trade and Industry, Other	832	416
Foremanship, Supervisor and Management Development	0	1066
Woodworking	296	148

The P_j values, as explained earlier, are based on historical data regarding placements for each vocational education program. With the knowledge of the solution's sensitivity to each rate the decision maker may undertake action to affect the appropriate rates. If the decision maker is able to change a rate, then the final value of the objective function will be reflected in the change in the number of training-related placements.

Sensitivity analysis was performed on the optimal solution to demonstrate the extent the coefficients (P_j) of the choice variables (X_j) must be changed, provided no other coefficients or constraints change, before the value of the optimal solution is changed. This analysis was conducted and the solution is presented in Table 10. Each program was listed along with P_j or placement coefficient for that program and the amount the placement rate would have to be changed before the optimal solution would change.

Each program was rank ordered with the program that requires the least change in contribution rate ranked first and the one requiring the greatest change ranked last. This enables the planner to identify those occupations where the improvements in placement rates (P_j) values would make the largest contributions toward maximizing the objective function. The planner can then allocate resources to improve the placement rates in those occupations accordingly.

TABLE 10

SENSITIVITY ANALYSIS OF PLACEMENT RATES:
INITIAL APPLICATION

OE Program	Contribution Coefficient	Required Change
Miscellaneous Distribution	.34	.0765
Quantity Food Occupation	.40	.0984
Health Occupation, Other	.29	.100
Dental Assistant	.51	.101
Practical Nurse	.71	.102
Electrical Occupation	.38	.106
Plumbing & Pipefitting	.28	.109
Office Occupation, Other	.28	.110
Leatherworking	.33	.111
Hardware, Building Material, Farm & Garden Supplies & Equipment	.34	.113
Advertising Services	.36	.116
Mail & Postal Clerks	.23	.116
Information Communication Occupation, Other	.23	.116
General Merchandise	.25	.122
Floristry	.29	.123
Auto Body	.38	.123
Auto Mechanics	.40	.123
Barbering	.52	.123
Cosmetology	.52	.123
Home Furnishings	.35	.124
Electronic Occupations	.24	.124
Commercial Art Occupations	.29	.126
Textile Production & Fabrication	.39	.126
Woodworking	.26	.126
Trade & Industry, Other	.36	.127
Recreation & Tourism, Other	.25	.127
Air Conditioning	.43	.127
Carpentry	.30	.127
Automotive	.35	.129
Transportation	.47	.130
Painting & Decorating	.36	.130
Stationary Energy Sources	.25	.133
Electricity	.48	.134
Roofing	.36	.134
Construction Maintenance Trades, Other	.49	.134
Public Service Occupation, Other	.34	.135
Stenographic, Secretarial & Related Office Occupations	.36	.135

(To be continued)

TABLE 10 (Continued)

OE Program	Contribution Coefficient	Required Change
Typing	.28	.135
Apparel & Accessories	.37	.138
Drafting	.33	.140
Food Distribution	.37	.142
Filing, Office Machine, & General Office Clerical Help	.33	.146
Electrical Appliances	.43	.147
Metalworking	.43	.147
Aircraft Maintenance	.36	.149
Graphic Arts Occupation	.35	.156
Petroleum	.44	.157
Business Data Processing Systems Occupation	.28	.157
Food Service	.32	.158
Electrical Technology	.50	.160
Accounting & Computing	.22	.167
Masonry	.57	.168
Business Machine Maintenance	.36	.171
Commerical Pilot Training	.50	.193
Miscellaneous Technical Education, Other	.50	.193
Foremanship, Supervisor, & Management Development	.27	.212
Agriculture	.41	.231
Radiologic Technician	.29	.240
Production Agriculture	.36	.273
Agriculture Mechanics	.41	.283

Summary of Linear Programming Application

The use of linear programming as a decision-making tool was described in detail. First, the mathematical formulation of the model which depicted Missouri's system of vocational education was presented. The objective function and the constraints were identified and formulated mathematically.

The model was then applied to Missouri's system and a solution (program mix) was found that maximized the placement of students in training related occupations. To illustrate the use of linear programming in simulating the systems environment, two additional applications were made. In the second application the resources available were increased and a solution was found. In the third application projected job openings were increased for each program and a third solution was found.

The applications presented in the chapter, of course, did not exhaust the actual applications of the model as used in forming the plan for Task Force 1990. It is also worth noting that the technique is useful in situations like these as well: locating area vocational schools, finding a program mix that minimizes costs, or finding a program mix that maximizes students served. The applications presented did illustrate the potential the technique offers the decision maker in planning vocational education programs.

CHAPTER VII

THE DECISION-MAKING SUPPORT SYSTEM: GOAL PROGRAMMING APPLICATION

The second decision-making tool to discuss is goal programming. As in the linear application, there are two steps which are relevant to an understanding of the technique. First, the goal programming model must be formulated. Second, the model must be applied to the system under study.

Formulation of the Goal Programming Model

In the development of the goal programming model the first consideration is the identification of choice variables. As was the case in the linear programming model the number of completers for each program area was selected as a choice variable.

Once the choice variable was selected, system constraints were identified. The constraints were the same as those used in the linear programming model. In goal programming, however, the formulation of these constraints differ. Mathematically they were formulated as follows:

A. Projected Occupational Openings

$$A_j X_j - d_j^+ = PO_j \quad (j = 1 \ldots n) \qquad (2.2)$$

The PO_j in the above equation are equal to the projected occupational openings for occupations that require some type of vocational training. The A_j is equal to the inverse of the fractional equivalent of the percent of the occupational openings for that occupation filled by vocational education graduates in the past. The X_j values are the choice variables or completers for program j. The d_j^+ values are the deviational variables to minimize so that program completers do not exceed the projected occupational openings for that occupation (j).

B. Availability of Students

$$\sum_{j=1}^{N} L_j X_j - e_1^+ = PE \qquad (2.3)$$

In this constraint, PE was equal to 50 percent of the projected enrollment of students in grades 11-12 in the state. The number of completers of each program was equal to X_j. The L_j is the length of the program (1-4 years). By minimizing the deviational variable e_1^+ the constraint that vocational education enrollment in all programs could not exceed 50 percent of the total projected enrollment (grades 11-12) for the state was met.

C. Budget

$$\sum_{j=1}^{N} C_j X_j - b_2^+ = B \qquad (2.4)$$

The budget constraint (B) limits the amount of funds that can be spent on vocational education programs. As before, the X_j equaled the number of completers of occupational programs j in the state. The cost of educating each program completer was equal to the value, C_j. The b_2^+ limited the funds to be spent on vocational education so as not to exceed funds which were available.

D. Disadvantaged

$$D_j \; X_j + v_3^- = DIS \qquad (2.5)$$

This constraint (DIS) required 15 percent of vocational completions in the state to be disadvantaged students and was set at a level of 10 percent over the previous year. This equation forces the solution to exceed or equal the disadvantaged constraint. The D_j is derived by calculating the percent of completers from each program who are disadvantaged.

Determining Goals

The next step in the formulation was to establish priorities for the goals of vocational education in Missouri. A study of state and local administrators of vocational education by Elbert found the following rankings of goals by leaders in vocational education in Missouri.[18]

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[18]Dennis J. Elbert, The Identification and Relative Importance of Elements in the Missouri System of Vocational Education (Unpublished Doctoral Dissertation, University of Missouri-Columbia, 1976).

Ranking of Goals

1. Increase the number of completers placed in training related jobs.
2. Increase the labor force participation of program completers.
3. Increase the number of completers.
4. Increase the number of students continuing education after completing the vocational program.

The results of this study provided the rationale for ranking these goals in the model. The above goals were operationalized in the model by quantifying them as follows. Mathematically each goal became:

A. Increase the number of completers placed in training related jobs:

$$\sum_{j=1}^{N} P_j X_j + r_4^- = TR \qquad (2.6)$$

In this goal the P_j values were the placement rates derived from historical data from program j in the state. The X_j values were the number of completers of each program j. The TR was the previous year's placements in training-related jobs increased by 10 percent. The training-related placement goal was 8065 for 1976.[19]

Simply stated, the goal, as formulated, was to increase the number of completers placed in training-

[19]Missouri Department of Elementary and Secondary Education, Research Coordinating Unit, MOTIS Tapes and Reports on Vocational Enrollments for school year 1974-1975.

related jobs by 10 percent. The r_4^- values was the negative deviation from the goal that was to be minimized. Since the deviational variable had a positive sign, the number of training-related placements had to exceed the previous year's placements by 10 percent or more.

B. Increase the labor force participation.

$$\sum_{j=1}^{N} LFPR_j \, X_j + f_5^- = LFP \qquad (2.7)$$

The coefficient ($LFPR_j$) of the choice variables (X_j) equaled the labor force participation rate of completers of program j and was based upon the percent of completers of the program who were either employed or unemployed. LFP equaled the number of completers from the previous year who were in the labor force, increased by 10 percent for this year.[20] The labor force participation goal was 13,689 for 1976. The deviational variable f_5^- was the difference between the labor force participation of program completers from the previous year and projected vocational graduates. Of course, the goal was to minimize the negative deviation, which was to make the LFP of future vocational graduates as large as possible, that is, as far above 13,689 as posssible.

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[20] Ibid. MOTIS Tapes and Reports.

C. Increase the number of completers.

$$\sum_{j=1}^{N} G_j X_j + c_6^- = C \qquad (2.8)$$

A goal of 24,446 for the number of completers was set which was 10 percent over the previous year's completions. All G_j values were determined to be equal to one since a completer was weighed the same regardless of which occupational program he/she completed.

D. Increase the number of students continuing their education.

$$\sum_{j=1}^{N} BS_j X_j + p_7^- = CE \qquad (2.9)$$

The BS_j coefficients were derived from historical data on each occupational program (j) and represent the percent of completers continuing their education. The goal constraint (CE) was established at a level of 10 percent above the previous year. The constraint specified that the deviational variables p_7^- should force the choice variables so that the number of completers continuing their education in the state was equal to or greater than the goal (CE). The goal for those who would continue their education was set at 5,757.[21]

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[21] Ibid. MOTIS Tapes and Reports.

The Objective Function

Mathematically the objective function was:

$$\text{MIN } Z = 1P_1 \sum_{j=1}^{N} d_j^+ + 2P_1 \sum_{j=1}^{N} d_j^+$$

$$+ 3P_1 \sum_{j=1}^{N} d_j^+ + P_2 r_4^- + P_3 c_6^- + P_4 b_2^+$$

$$+ P_5 f_5^- + P_6 v_3^- + P_7 e_1^- + P_8 p_7^-$$

The objective function was designed to minimize the deviation of goal accomplishment. The P's represent the priority level of each goal. That is, P_1 indicates that the deviation to be minimized (d_j^+) receives the highest priority and only after meeting this particular goal will the other goals be met. P_2 is the second priority goal and will be met second, etc. The goals to be accomplished as represented in the model were:

Goal 1: To train no more students in a vocational program than there were projected job openings.

Goal 2: Limit vocational enrollments to fifty percent of secondary 11th and 12th grade students.

Goal 3: To limit the expenditure on vocational education programs to the resources available.

Goal 4: To increase the number of disadvantaged students served by ten percent over the previous year.

Goal 5: To increase the number of program completers placed in training related occupations by 10 percent.

Goal 6: To increase the labor force participation of vocational education graduates by 15 percent.

Goal 7: Increase the number of program completers to 24,000 students.

Goal 8: Increase the number of program completers who continue their education by 10 percent.

In the above equation each of these goals were assigned a priority level. The assignment was as follows:

Goal	Priority	Deviational variable
1	1	d_j^+
2	7	e_1^+
3	4	b_2^+
4	6	v_3^-
5	2	r_4^-
6	5	f_5^-
7	3	c_6^-
8	8	p_7^-

In addition, in the above equation, there were three different weights assigned to priority level one. Occupations in which there was a large number of projected openings were arbitrarily weighed 3. Those with a smaller number of projected openings were weighed 2 and those with a small number of projected openings by 1. The decision maker, in an actual application would, of course, decide on the weight to be given to the projected openings.

In solving the problem, the highest priority goals are met first, followed by those of lesser priority. Obviously, not all goals can be satisfied since several are clearly incompatible and conflicting. Of course, the goals could have been assigned different priority factors or weighted differently depending upon the decision makers' priority structure.

The Complete Model

Mathematically the goal programming model was formulated as:

$$\text{MIN} \quad Z = 1P_1 \sum_{j=1}^{N} d_j^+ + 2P_1 \sum_{j=1}^{N} d_j^+$$

$$+ 3P_1 \sum_{j=1}^{N} d_j^+ + P_2 r_4^- + P_3 c_6^- + P_4 b_2^+$$

$$+ P_5 f_5^- + P_6 v_3^- + P_7 e_1^- + P_8 p_7^-$$

Subject to:

$$A_j X_j + d_j^- - d_j^+ = PO_j \quad (j=1 \ldots N) \qquad (2.2)$$

$$\sum_{j=1}^{N} L_j X_j + e_1^- - e_1^+ = PE \qquad (2.3)$$

$$\sum_{j=1}^{N} C_j X_j + b_2^- - b_2^+ = B \qquad (2.4)$$

$$\sum_{j=1}^{N} D_j X_j + v_3^- - v_3^+ = DIS \qquad (2.5)$$

$$\sum_{j=1}^{N} P_j X_j + r_4^- - r_4^+ = TR \qquad (2.6)$$

$$\sum_{j=1}^{N} LFPR_j X_j + f_5^- - f_5^+ = LFP \qquad (2.7)$$

$$\sum_{j=1}^{N} G_j X_j + c_6^- - c_6^+ = C \qquad (2.8)$$

$$\sum_{j=1}^{N} BS_j X_j + p_7^- - p_7^+ = CE \qquad (2.9)$$

$$X_j \geq 0 \quad (j=1 \ldots N)$$

$$d_j\text{'s} \geq 0 \quad (j=1 \ldots N)$$

Application of the Model to Missouri's System

The purpose of the following explanation is to report on the application of the goal programming model to vocational education planning in Missouri. The model is presented as formulated first. Then it is presented in an application where the priorities were changed. Finally, an example of the model after changing the constraints is given. This demonstration should illustrate the adaptability of the goal programming model to changes in the decision making environment and demonstrate ways in which the decision maker can use the model to analyze the outcome of alternative decisions.

The Initial Application: Meeting the Multiple Goals Of Vocational Education

The goal programming technique, as described earlier, enables the decision maker to handle allocation problems that involve multiple and often incompatible

goals. Accordingly, the goal programming model was formulated to accomplish the following goals for vocational education in Missouri as identified by the Task Force 1990.

Goal 1 (Priority 1): To train no more students in an occupation than there are projected job openings.

Goal 2 (Priority 7): To limit vocational enrollments to fifty percent of secondary 11th and 12th grade students in the state.

Goal 3(Priority 4): To limit the expenditure on vocational education in the state to the resources available.

Goal 4 (Priority 6): To increase the number of disadvantaged students served by ten percent over the previous year.

Goal 5 (Priority 2): To increase the number of program completers placed in training related occupations by ten percent.

Goal 6 (Priority 5): To increase the labor force participation of vocational education completers.

Goal 7 (Priority 3): To increase the number of program completers to 24,000 students.

Goal 8 (Priority 8): To increase the number of program completers continuing their education by ten percent.

The goal programming model was applied and the solution is presented in Table 11. The goal of meeting projected job openings was met (Goal 1). Also the goal of serving less than 50 percent of the 11th and 12th grade secondary students was met (Goal 2). All of the resources available were used (Goal 3). The goal of increasing the number of program completers who are

TABLE 11

INITIAL SOLUTION TO GOAL PROGRAMMING MODEL

	Goal	Priority	Achieved	Deviation from goal
1	Projected job openings	1	yes	- 855
2	Limit on enrollment	7	yes	- 24,095
3	Limit on funds	4	yes	0
4	Disadvantaged completions	6	no	- 876
5	Training related placements	2	yes	+ 989
6	Labor force participation	5	no	- 146
7	Number of completers	3	yes	+ 2,575
8	Continuing education	8	no	- 634

disadvantaged was not met (Goal 4). Goal 5, increasing the number of training related placements, was exceeded by 989 students. The labor force participation of program completers (Goal 6) was not met; it was short by 146 completions. Goal 7, increasing the number of program completions, was exceeded by 2,575 students. The number of completers continuing education missed the target (Goal 8) by 634 students. The final level of each goal is presented in Table 12.

TABLE 12

FINAL LEVEL OF EACH GOAL IN THE GOAL PROGRAMMING MODEL

	Goal	Deviation	Level
1	Projected openings filled	-855	26,167
2	Vocational enrollments	-24,095	57,426
3	Funds spent	0	$75,727,536
4	Disadvantaged completers	-876	2,724
5	Training-related placements	-989	9,054
6	Labor force participants	-146	13,543
7	Completions	+2,575	26,167
8	Continuing education	-634	5,123

The solution presented in Table 12 is based upon the program mix presented in Table 13. This table reflects the number of completions needed from each program area to reach the initial solution.

The mix of programs which minimizes the deviations from goals or in turn accomplishes the greatest number of the goals of vocational education in Missouri is presented in Table 13. The vocational planner, in an effort to accomplish the greatest number of goals, would make program changes such that the existing program mix would more closely mirror this idealized program mix.

TABLE 13

DISTRIBUTION OF COMPLETIONS: INITIAL APPLICATION

OE Program	Number of Completions	Projected Openings
Agriculture Services & Supplies	23	23
Agriculture Mechanics	44	112
Production Agriculture	2488	2504
Advertising Services	21	21
Apparel and Accessories	510	583
Automotive	476	476
Floristry	23	23
Food Distribution	833	1048
Food Service	35	35
General Merchandise	148	148
Hardware, Bldg. Materials, Farm & Garden Supplies and Equipment	516	516
Home Furnishings	124	124
Petroleum	56	56
Recreation and Tourism, Other	11	11
Transportation	1537	1537
Miscellaneous Distribution	401	401
Dental Assistant	68	68
Practical Nursing	700	700
Radiologic Technician	0	55
Health Occupations, Other	281	426
Accounting and Computing	3760	3759
Business Data Processing System Occupations	0	321
Filing, Office Machines & General Office Clerical Help	530	530
Mail & Postal Clerks	381	381
Information Communication Occupations, Other	326	326
Stenographic, Secretarial & Related Office Occupations	2867	2928
Typing	960	1036
Office Occupations, Other	473	544
Electrical Technology	41	41
Commercial Pilot Training	11	11
Miscellaneous Technical Education, Other	12	12
Air Conditioning	68	68
Electrical Appliances	86	86
Auto Body	109	209
Auto Mechanics	671	811

(continued)

TABLE 13 (Continued)

OE Program	Number of Completions	Projected Openings
Aircraft Maintenance	48	48
Business Machine Maintenance	17	62
Commercial Art Occupations	33	33
Carpentry	634	634
Electricity	265	265
Masonry	40	40
Painting and Decorating	309	309
Plumbing and Pipefitting	169	169
Roofing	11	11
Construction & Maintenance Trades, Other	119	119
Drafting	95	95
Electrical Occupations	81	81
Electronic Occupations	0	207
Graphic Arts Occupations	249	249
Metalworking	865	865
Barbering	256	256
Cosmetology	707	707
Public Service Occupations, Other	12	72
Quantity Food Occupations	68	68
Stationary Energy Sources	202	202
Textile Production and Fabrications	789	789
Leatherworking	293	293
Trade and Industry, Other	416	416
Foremanship, Supervisor and Management Development	1067	1066
Woodworking	148	148

Second Application: The Effect of Changing the Priorities of Goals for Vocational Education

The initial application meets the goals and objectives of vocational education in Missouri as specified in the previous section. Of course, the priorities assigned to each goal may be changed by the policy maker. When the priorities are changed, the results of the model's application are likely to change. To illustrate the effect of changing priorities, priority 1 was assigned to Goal 3 and priority 4 to Goal 1. Thus, the most important goal was changed from meeting projected job openings to limiting the expenditures on vocational education to the money available. The goal programming model was then applied. The results are presented in Table 14.

TABLE 14

SOLUTION TO SECOND APPLICATION

	Goal	Priority	Achieved	Deviation
1	Projected job openings	4	yes	-756
2	Limit on enrollment	7	yes	-23,662
3	Limit on funds	1	yes	0
4	Disadvantaged students	6	no	-854
5	Training-related placements	2	yes	+1,201
6	Labor force participation	5	yes	0
7	Number of completers	3	yes	+1,821
8	Continuing education	8	no	-781

The highest priority goal, the limit on funds spent, was met. The goal of meeting projected job openings (priority 4) was also met. The limit on enrollment (Goal 2) was met as well. The number of completers placed in training-related jobs exceeded the goal by 1201 (Goal 5). The number of completers in the labor force equaled the target, thus there was no deviation (Goal 6). In addition, the number of completers of all programs exceeded the goal by 1821 (Goal 7). Unfortunately, Goal 4, the number of disadvantaged completers, was missed by 854. As in the initial solution, the target for the number of completers continuing their education was not met (Goal 8). The final level of each goal is presented in Table 15.

TABLE 15

FINAL LEVEL OF EACH GOAL: SECOND APPLICATION

	Goal	Deviation	Level
1	Projected openings	-756	26,266
2	Vocational enrollments	-23,662	57,860
3	Funds spent	0	75,727,536
4	Disadvantaged	-854	2,746
5	Training-related placements	+1,201	9,266
6	Labor force participants	0	13,689
7	Completions	+1,821	26,266
8	Continuing education	-781	4,976

The distribution of completions by program area for the second application are presented in Table 16.

TABLE 16

DISTRIBUTION OF COMPLETIONS:
SECOND APPLICATION

OE Program	Number of Completions	Projected Openings
Agriculture Services & Supplies	23	23
Agriculture Mechanics	44	112
Production Agriculture	2596	2504
Advertising Services	21	21
Apparel and Accessories	510	583
Automotive	476	476
Floristry	23	23
Food Distribution	833	1048
Food Service	35	35
General Merchandise	148	148
Hardware, Bldg. Materials, Farm & Garden Supplies and Equipment	516	516
Home Furnishings	124	124
Petroleum	56	56
Recreation and Tourism, Other	11	11
Transportation	1537	1537
Miscellaneous Distribution	401	401
Dental Assistant	68	68
Practical Nursing	700	700
Radiologic Technician	0	55
Health Occupations, Other	281	426
Accounting and Computing	3760	3759
Business Data Processing System Occupations	0	321
Filing, Office Machines & General Office Clerical Help	530	530
Mail & Postal Clerks	381	381
Information Communication Occupations, Other	326	326
Stenographic, Secretarial & Related Office Occupations	2867	2928
Typing	960	1036
Office Occupations, Other	473	544
Electrical Technology	41	41
Commercial Pilot Training	11	11
Miscellaneous Technical Education, Other	12	12
Air Conditioning	68	68
Electrical Appliances	86	86
Auto Body	109	209
Auto Mechanics	671	811

(continued)

TABLE 16 - Continued

OE Program	Number of Completions	Projected Openings
Aircraft Maintenance	48	48
Business Machine Maintenance	17	62
Commercial Art Occupations	33	33
Carpentry	634	634
Electricity	265	265
Masonry	40	40
Painting and Decorating	309	309
Plumbing and Pipefitting	169	169
Roofing	11	11
Construction & Maintenance Trades, Other	119	119
Drafting	95	95
Electrical Occupations	81	81
Electronic Occupations	207	207
Graphic Arts Occupations	249	249
Metalworking	865	865
Barbering	256	256
Cosmetology	707	707
Public Service Occupations, Other	12	72
Quantity Food Occupations	68	68
Stationary Energy Sources	202	202
Textile Production and Fabrications	789	789
Leatherworking	148	293
Trade and Industry, Other	416	416
Foremanship, Supervisor and Management Development	1066	1066
Woodworking	0	148

While this application illustrated the switching of the priorities assigned to the goal of meeting projected job openings and the goal of funds to be spent, there are many other combinations that are possible. The important point is that the decision maker can analyze the effect of changing goals for vocational education by using different priority structures in the model once it has been formulated.

Third Application: Changing the Value of Constraints

Not only can the decision maker change the priority structure, but the value of the constraints in the model can also be changed. To illustrate the effect of such a change the funds that were available for vocational education were increased by 10 million to $85,27,536. The model was then applied and the results are presented in Table 17.

TABLE 17

SOLUTION TO GOAL PROGRAMMING MODEL THIRD APPLICATION

	Goal	Priority	Achieved	Deviation
1	Projected job openings	4	yes	0
2	Limit on enrollment	7	yes	-21,599
3	Limit on funds	1	yes	-5,727,339
4	Disadvantaged students	6	no	-760
5	Training-related placements	2	yes	+1,254
6	Labor force participation	5	yes	+174
7	Number of completers	3	yes	+2,576
8	Continuing education	8	no	-427

By increasing the funds spent, only Goals 4 and 8 remained unmet. As would be expected, more students were served, more completers who were disadvantaged were served, more training-related placements occurred, more completers were in the labor force, and more completers were continuing education (compare Table 12 and 18). It is important to note that not all of the funds available were spent. There were nearly 6 million dollars left over. Simply put, to

accomplish the above goals it did not require 10 million dollars, only 4 million. The final level of each goal is presented in Table 18. Table 19 presents the distribution of completions by program area for the third application.

TABLE 18

FINAL LEVEL OF EACH GOAL THIRD APPLICATION

	Goal	Deviation	Level
1	Projected openings	0	27,022
2	Vocational enrollments	-21,599	59,923
3	Funds spent	-5,727,339	$80,000,197
4	Disadvantaged	-760	2,840
5	Training-related placements	+1,254	9,319
6	Labor force participants	+174	13,802
7	Completions	+2,576	27,022
8	Continuing education	-427	5,331

TABLE 19

DISTRIBUTION OF COMPLETIONS THIRD APPLICATION

OE Program	Number of Completions	Projected Openings
Production Agriculture	2504	2504
Agricultural Supplies & Services	23	23
Agricultural Mechanics	44	112
Advertising Services	21	21
Apparel and Accessories	510	583
Automotive	476	476
Floristry	23	23
Food Distribution	833	1048
General Merchandise	148	148

(continued)

TABLE 19 - Continued

OE Program	Number of Completions	Projected Openings
Hardware, Bldg. Materials, Farm & Garden Supplies and Equipment	516	516
Home Furnishings	124	124
Petroleum	56	56
Recreation and Tourism, Other	11	11
Transportation	1537	1537
Dental Assistant	68	68
Practical Nursing	700	700
Miscellaneous Distribution	401	401
Radiologic Technician	0	55
Health Occupations, Other	281	426
Accounting and Computing	3759	3759
Business Data Processing System Occupations	321	321
Filing, Office Machines & General Office Clerical Help	530	530
Mail & Postal Clerks	381	381
Information Communication Occupations, Other	326	326
Stenographic, Secretarial & Related Office Occupations	2856	2928
Typing	960	1036
Office Occupations, Other	473	544
Electrical Technology	41	41
Commercial Pilot Training	11	11
Miscellaneous Technical Education, Other	12	12
Air Conditioning	68	68
Electrical Appliances	86	86
Auto Body	109	209
Auto Mechanics	671	811
Aircraft Maintenance	48	48
Business Machine Maintenance	17	62
Commercial Art Occupations	33	33
Carpentry	634	634
Electricity	265	265
Masonry	40	40
Painting and Decorating	309	309
Plumbing and Pipefitting	169	169
Roofing	11	11
Construction & Maintenance Trades, Other	119	119
Drafting	95	95
Electrical Occupations	81	81
Electronic Occupations	207	207
Graphic Arts Occupations	249	249
Metalworking	865	865

(continued)

TABLE 19 - Continued

OE Program	Number of Completions	Projected Openings
Barbering	256	256
Cosmetology	707	707
Public Service Occupations, Other	12	72
Quantity Food Occupations	68	68
Stationary Energy Sources	202	202
Textile Production and Fabrications	789	789
Leatherworking	293	293
Trade and Industry, Other	416	416
Foremanship, Supervisor and Management Development	1066	1066
Woodworking	148	148

Summary of Goal Programming Application

The above applications of the goal programming model exemplify the flexibility in the goal programming technique. The decision maker can simulate the effect of alternative decisions simply by changing the priorities, goals, or constraints in the model. In addition, the applications revealed several characteristics of the technique. For one, it is not unusual in a goal programming application to derive a solution that does not satisfy all the goals in the model.

Also, as was illustrated, several of the goals in the model may be in conflict, such as a conflict between placing the greatest number of completers in training-related occupations and encouraging completers to continue higher education. As was revealed, although the goals may

be incompatible, as long as the decision maker is capable of establishing the ordinal importance of these goals, then the goal programming technique will provide a solution that is optimal in terms of the specified priority structure.

As with the linear programming application presented in the previous chapter, the goal programming applications are samples of the applications used in forming the plan for vocational education in the State of Missouri by Task Force 1990. The goal programming applications presented do exemplify the potential the technque offers the vocational education program planner.

CHAPTER VIII

DECISION MAKING SUPPORT SYSTEM: MULTIVARIATE STATISTICAL APPLICATION

The purpose of this chapter is to illustrate the application of multivariate statistics to vocational education planning. The problem of concern was that of projectin occupational employment. One of the frequently heard complaints is that employment projections, as they usually exist, are not suitable for vocational education program planning. Given this complaint, a means of modifying projected employment as supplied by the Missouri Occupational Training Information System (MOTIS) was developed. First, a review of the projection methodology is in order.

MOTIS Projection Methodology

The methodology used in the MOTIS system is similar to the technique for projecting employment developed by the Bureau of Labor Statistics (BLS).[22] This technique, known as the occupational-industrial matrix approach, requires that the following estimates be made.

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[22]U.S. Department of Labor, Bureau of Labor Statistics, Tomorrow's Manpower Needs, Vol. 1, Bulletin Number 1606 (Washington, D.C.: Government Printing Office, February, 1969).

1. Projections of Industry Employment. Estimates of industry employment are derived by preparing a time series of wages and salary employment at the appropriate level of geographic detail, which is then used to project the target year employment. In order to make this estimate, a statistical technique, the method of "ordinary least squares" is used to estimate a function from the time series data. Since these projections exclude government employees, the self-employed, and unpaid family workers, adjustments are made to include these groups in the projections.

2. Projections of Industry/Occupational Rates. The 1970 Census data for Missouri are used to develop tables of ratios of employment. These are developed by comparing the number of workers in a specific occupation in each industry to the total employment in that industry. Each industry's estimated total employment for the base year is multiplied by its occupation ratios and the results are summed over all industries to yield total employment by occupation for the projected year (target year). The same procedure is followed for projecting each industry's projected employment. Then, employment growth for the projection period is obtained by subtracting base year employment from target year employment.

3. Projections of Replacement Due to Withdrawal From the Labor Force. Replacements are computed by applying labor force separation rates to age and sex distributions of average projected employment by occupation. This yields total estimated separations by occupation over the projection period.[23]

The preceding process is diagramatically represented in Figure 9.

Employment Projection Process

The first stage in the process is the projection of industry employment. These projections are made by

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[23]Missouri Department of Elementary and Secondary Education, Research Coordinating Unit, MOTIS Technical Report, by James Pershing and Richard Tiller (Jefferson City, Missouri, 1973).

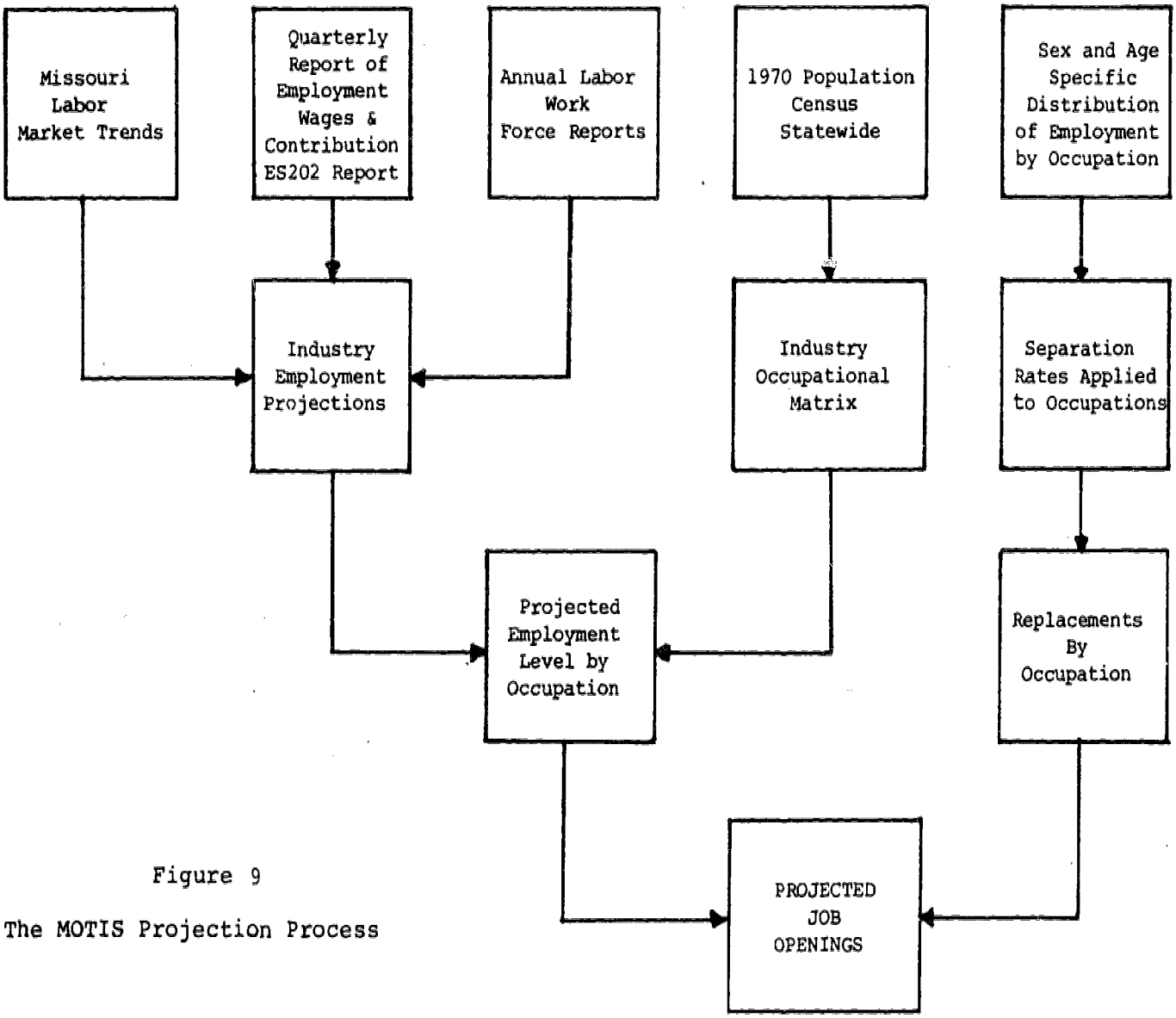

Figure 9

The MOTIS Projection Process

collecting "operating" data and "establishment" data from employers. Operating data are secured from required reporting such as unemployment tax records and quarterly wage reports. Establishment data are secured from surveys of the place of employment, such as the Current Employment Survey (CES) which is conducted by the Missouri Employment Service. Both operating and establishment data are used by MOTIS and include the following data series:

1. Missouri State and Area Labor Market Trends
2. Quarterly Report of Employment, Wages and Contributions (ES 202 Reports)
3. Annual Labor Area Work Force Reports

Different combinations of these series are used. In general, the ES-202 data are used whenever possible since they provide the greatest amount of industry detail. Exceptions occur because employees of certain industries are not covered by unemployment insurance. In the past, coverage has been lax or nonexistent for small firms, private nonprofit institutions, state and local governments, railroads, and agriculture. Therefore, in these cases, data sources other than the ES-202 are more appropriate.

Once the data are collected, the time series are examined for trends that can be extrapolated. Four models are estimated for each industry series by the method of "ordinary least squares" to detect the presence of non-linear as well as linear trends.

These four models presented below are used to project employment to the target year. In the past, the linear model was found to be the best predictor since it had the largest coefficient of determination (R^2). [24]

1. $Y_{ai} = a + bt$
2. $Y_{ai} = a + b \ln t$
3. $\ln Y_{ai} = a + bt$
4. $\ln Y_{ai} = a + b \ln t$

Y_{ai} = Area Employment in the i^{th} industry;

t = time

Next, an adjustment is made so the data will reconcile with census information since these data do not include those that are self-employed or unpaid family and domestic workers. Although there are other differences between payroll and census data, additional adjustments are not made because it is unlikely that these differences will have a significant overall effect.[25]

The next step in the process is the conversion of projected employment for each industry sector to projected

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[24] Ibid.

[25] Other differences between census data and payroll data include the following:

(1) The census counts persons as employed once while payroll data reflect multiple job holdings.

(2) The census counts persons employed by residence while payroll data reflect place of employment.

occupational employment. This conversion is accomplished by constructing a statewide industry/occupational matrix which is then applied to projected employment for the state.

In 1973, a matrix was developed for each of thirteen geographic areas but was discontinued in 1974 and replaced by a statewide matrix. A statewide matrix was developed because substantial industry detail was lost when separate area matrices were developed.[26] In using the statewide matrix, it is assumed that the percentage of an occupation in a given industry is the same in every part of the state.

Once the matrix is developed, occupational projections are derived by multiplying the projected year's industry employment by the industry/occupation (I/O) matrix and summing over all industries to arrive at occupational employment. Algebraically, this is expressed as follows:

$$L_i\ (1981) = \Sigma \frac{L_{ij}\ (1970)}{L_j\ (1970)} L_{nj}\ (1981)$$

where:

L_{ij} = amount of employment in the i^{th} occupation.

L_j = total amount of employment in the j^{th} industry.

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[26] In 1973, an Industry/Occupation (I/O) Matrix was developed for each area separately. The Public Use Sample (PUS) tapes were used to construct the matrices. Since the PUS used a very small sample size, it was not possible to construct the matrices at the level of detail needed by vocational planners. In short, too much industry detail was lost. In turn, the matrix in 1974 was based upon the 1970 population census for the state as a whole.

L_{nj} = industry/occupation coefficient giving the proportion of employment in the i^{th} occupation and j^{th} industry to total employment in the j^{th} industry.

L_i = total amount of employment in the i^{th} occupation.[27]

The final step in the projection process is the estimation of replacements by occupation. Replacements are those who withdraw from the labor force because of death or retirement. Replacements are computed by obtaining age and sex distributions for each occupation which are based on the decennial census of population. Then, occupational distributions are multiplied by average employment for the projection period which are multiplied by specific separation rates for age and sex. Finally, separations for each occupation are obtained by adding the age and sex groups separations for each occupation.[28]

After replacement projections are estimated for an occupation, they are added to net growth in job openings in the occupation. This sum represents the total number of projected employment opportunities for an occupation and completes the process of projecting employment by occupation.

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[27]The separation rates, referred to above, are taken from tables in Volume I of Tomorrow's Manpower Needs. The rates in the tables are derived by follow-up on a sample of 100,000 people, who are followed for life. From the follow-up, rates of mortality, labor force accession, and retirement are compiled into separation rate tables.

[28]Missouri Department of Elementary and Secondary Education, Research Coordinating Unit, MOTIS Employment and Job Openings Projections: 1975-1981.

Weaknesses in MOTIS Projections

Several issues in the development of the MOTIS employment projections create problems for vocational education planners. First, the matrix is built upon data from the 1970 census. The use of these data is based on the assumption that an industry's occupational structure changes slowly over time. Of course, the occupational structure of an industry may not remain constant but may vary from one decennial census to the next. A solution to this problem may be a program developed jointly by the Bureau of Labor Statistics and State Divisions of Employment Security to collect occupational data on an annual basis in those industries where rapid changes occur frequently. This program, known as the Occupational Employment Statistics (OES) program, should improve the quality of occupational projections for vocational education planning.[29]

Another problem with the census data is accuracy. The data may be inaccurate because of the method by which they are gathered. The data are gathered by household interviews. The respondents are asked to report the occupations of those in the household. The responses are subjective since the occupations reported are based on the perception of the respondents and this perception may not be

[29]Harold Goldstein, "The New Federal-State Occupational Employment Statistics Program", Monthly Labor Review (October, 1971), pp. 12-17.

accurate. The actual classification of occupations is done by census-takers who are also reporting their perceptions of the respondents replies.

Aside from the subjective element of the census data, it is questionable whether the Census Occupational Classification System is appropriate for vocational education planning. The classification system consists of 417 three-digit occupations used for arraying the occupational data of the decennial census (see Appendix I, Table AI-1). Each of these occupations is defined by a long list of job titles from various industries. The reasons for grouping the jobs are not at all clear. As stated by Scoville:

> The census occupational classification was developed over a period of some sixty years, in a series of separate efforts by economists, sociologists, and census takers. The focal interest of the classification did, however, remain remarkably constant -- the measurement of the importance of various social and economic classes in the U.S.[30]

Whether these occupational classifications provide the specific information needed by the vocational education planner regarding skills and techniques to include in an instructional program is questionable. This needs to be explored; perhaps other classification schemes such as the Occupational

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[30]James Scoville, Manpower and Occupational Analysis, Conducts and Measurement (Lexington, MA: D.C. Heath, Inc., 1972), p. 25.

Employment Statistics (OES) or the Standard Occupational Classification (SOC) would better meet the needs of the vocational education planner.[31]

Another weakness in the MOTIS projection technique is in the conversion of industry employment to occupational employment which is classified by vocational program area. The MOTIS System converts projected employment by Census Code to Dictionary of Occupational Title Code. The projected employment by DOT Code is then converted to United States Office of Education (USOE) Code which becomes the projected employment by vocational program area. For these projected employment data to be usable, occupations which are not appropriate for vocational education training must be dropped from the projections.

Specifically, occupations that require baccaluareate degrees or no skill training should be dropped from projected occupational openings. Projections made by the MOTIS system for 1976-1982 failed to drop out many of these professional and unskilled occupations.[32] Included in the MOTIS projections were occupations such as systems analysts, farm

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[31]Alan Roskam, Labor Market Analysis and Educational Planning: A Test of the Competitive Hypothesis (Missouri: University of Missouri-Columbia, 1975), p. 168.

[32]Missouri Department of Elementary and Secondary Education, Research Coordinating Unit; MOTIS Employment and Job Openings Projections: 1975-1981.

laborers, waiters, busboys, housekeepers, and maids and servants. The inclusion of these occupations distorts projected employment for use in vocational education program planning. For example, in 1975 total projected employment by industry for the state was 2,121,991. This employment, converted to openings by vocational program areas was 1,461,898 (see Appendix I, Tables AI-2 and AI-3). In effect, the MOTIS technique eliminated 666,083, or approximately 31 percent of the projected job openings from the state's total projected employment. The implication is that 69 percent of the projected job openings require vocational education preparation (that is, education less than baccalaureate degree level but requiring some skill preparation).[33] Apparently the MOTIS system has failed to identify those occupations requiring vocational education training.

To do so an analysis of each occupation is needed to identify aptitudes, skills, and other characteristics required of workers in each occupation. Employment projections based on this kind of analysis would be more realistic since occupations that require no skill preparation or those requiring baccalaureate or higher degrees would not be included in the projected employment used in vocational education planning.

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[33] Ibid.

Modifications of Employment Projections

So that MOTIS employment projections could be used in vocational education program planning and in the linear and goal programming models employed in this project, the projections were modified. A technique was developed that eliminated from the employment projections those occupations that required baccalaureate or higher degrees and those requiring no specific skill preparation. The employment projections that resulted reflected only those occupations which require vocational education preparation.

The approach to the development of this technique centered around a multivariate statistical technique known as multiple discriminant analysis. This technique has been used successfully by Pinches,[34] Tatsuoka,[35] McKeon,[36] and others to explain and predict intergroup differences. The technique enables the user to predict or classify unclassified objects, as well as explain the way selected variables determine group membership.

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[34]George E. Pinches and Kent A. Mingo, "The Hierarchical Classification of Financial Ratios", Journal of Finance, 23 (November, 1974), pp. 1-18.

[35]Maurice M. Tatsuoka, Multivariate Analysis (New York: John Wiley & Sons, Inc., 1971), pp. 217-225.

[36]Ibid.

Discriminant analysis was used for both explanation and classification in this study. The explanation phase consisted of identifying predictor variables which maximized the group separation of vocational, untrained, and professional occupational groups. The output of this application was a discriminant function which was then used to categorize unclassified occupations as either vocational, untrained, or professional. The classification phase of the analysis was in reality a separate and distinct application of discriminant analysis.

The explanation phase consisted of identifying three groups of occupations (25 occupations in each group) which were identifiable as occupations that required either no specific preparation (untrained), preparation in a vocational education program, or preparation at the baccalaureate or higher degree level (professional). These occupations and their group membership are listed in Table 20. They were selected from among the 417 occupational codes used in the Census Classification system (see Appendix I, Table AI-1).

Once the groups were formed, data were sought on each occupation. Since a great deal of information on jobs is present in the Dictionary of Occupational Titles (DOT)[37] and each Census Occupation is convertible to DOT numbers,

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[37] U.S. Department of Labor, Dictionary of Occupational Titles, Vol. II (Washington, D.C.: U.S. Government Printing Office, 1965), p. 649.

TABLE 20

GROUP MEMBERSHIP OF OCCUPATIONS USED TO DERIVE DISCRIMINANT FUNCTION

Professional	Vocational	Untrained
Priests	Forestry Aids	Telephone Operators
Employment Counselor	Dental Assistants	Auto Salesmen
Civil Engineers	Dental Lab. Technicians	Waiters & Waitresses
Meteorologists	Medical Assistants	Guards & Watchmen
Journalists	Surgical Technicians	Private Household Workers
College Teachers	Engineering & Science Tech.	Building Custodians
Landscape Architects	Draftsmen	Models
Psychologists	Bookkeeping Workers	Paperhangers
City Managers	Office Machine Operator	Over-the-road Truckdrivers
Accountants (CPA)	Stenographers & Secretaries	Taxi Drivers
Lawyers	Typists	Parking Attendants
Physicians	Cosmetologists	Service Station Attendants
Musicians	Carpenters	Farm Laborers
Actors	Electricians (Construction)	Bartenders
Economists	Plumbers and Pipefitters	Drywall Installers
Mathematicians	Sheet-Metal Workers	Garbage Collectors
Agriculture Scientists	Air Cond. & Refrig. Mech.	Laundry Operators
Business Teachers	Auto Body Repairmen	Meter Readers
Financial Managers	Instrument Repairmen	File Clerks
School Administrators	TV and Radio Service Tech.	Painters
Computer System Analysts	Aircraft Maintenance	Gardeners
Television Announcers	Bricklayers	Railroad Brakemen
Geologists	Machinists	Messengers
Financial Analysts	Auto Mechanics	Doormen

the Dictionary of Occupational Titles was used as a source of data on each occupation (see Appendix I, Table AI-4). The DOT classifies each job on the basis of the way each worker is required to function with data, people, and things. These relationships are identified in Table 21. They appear in the form of three hierarchies arranged from the relatively simple to the more complex. Each job's relationship to these three functions is represented in the last three digits of the DOT code. These digits were assigned the tabulated values depending upon the relationship the job has to each of these functions: data, people, or things.

TABLE 21

THE RELATIONSHIP OF EACH OCCUPATION TO DATA, PEOPLE, AND THINGS[38]

Data		People		Things	
0	Synthesizing	0	Mentoring	0	Setting-Up
1	Coordinating	1	Negotiating	1	Precision Working
2	Analyzing	2	Instructing	2	Operating-Controlling
3	Compiling	3	Supervising	3	Driving-Operating
4	Computing	4	Diverting	4	Manipulating
5	Copying	5	Persuading	5	Tending
6	Comparing	6	Speaking-Signaling	6	Feeding-Offbearing
7	No significant	7	Serving	7	Handling
8	relationship	8	No significant relationship	8	No significant relationship

[38] Ibid.

In addition to the above measures, the DOT also contains information on each job in terms of distinct worker traits required for successful job performance. The worker trait information includes:

1. The amount of general education development and specific vocational preparation a worker must have.
2. The specific capacities and abilities required of a worker in order to learn or perform certain tasks or duties.
3. Preferences for certain types of work activities or experiences considered necessary for job success.
4. Types of occupational situations to which an individual must adjust.
5. Physical activities required in work situations.
6. Physical surrounding prevalent in jobs.[39]

For this study only the information on the first and second worker traits were included in the analysis.

The two broad worker traits used were general educational development and aptitudes. These broad traits were further categorized into two variables that measured educational development and eleven variables which measured aptitudes. Including the previously mentioned variables that depict a job relationship to data, people, and things these variables make a total of sixteen variables which were used to predict group membership as either vocational, professional, or no-skill occupations.

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[39] Ibid., pp. 649-654.

Inasmuch as the first three variables (data, people, and things) have already been described, the additional thirteen variables used to classify each occupation need to be discussed. The fourth and fifth variables were used to measure educational development and were based on the amount of general education and specific vocational preparation required of a worker to acquire the knowledge and abilities necessary for average performance on the job. General educational development embraces those aspects of education which contribute to the worker's (a) reasoning development and ability to follow instructions, and (b) acquisition of "tool" skills, such as language and mathematical skills. It is education of a general nature which does not have a recognized or fairly specific occupational objective. The DOT identifies six levels of reasoning development, mathematical development, and language development. In the DOT each occupation is assigned a numerical value of from one to six. These measures, in turn, were used in the discriminant analysis to represent general educational development.[40]

The fifth variable used to measure specific vocational preparation is defined by the DOT as the amount of time required to learn the techniques, acquire information and develop the facility needed for average performance in

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[40] Ibid.

a specific job situation. This preparation may be acquired in school, work, military, institutional, or a vocational environment. Specific vocational preparation includes training given in any of the following circumstances:

a. Vocational education (such as high school, commercial or shop training, technical school, art school and that part of college training which is organized around a specific vocational objective requiring less than baccalaureate level preparation);

b. Apprentice training (for apprenticeable jobs as classified by the Bureau of Apprenticeship and Training);

c. In-plant training (given by an employer in the form of organized classroom study);

d. On-the-job training (serving as learner or trainee on the job under the instruction of a qualified worker);

e. Essential experience in other jobs (serving in less responsible jobs which lead to the higher grade job or serving in other jobs which qualify).

The following seek to define the various levels of specific vocational preparation.

Level	Time
1	Short demonstration only.
2	Anything beyond short demonstration up to and including 30 days.
3	Over 3 months up to and including 6 months.
4	Over 6 months up to and including 9 months.
5	Over 9 months up to and including 1 year.
6	Over 1 year up to and including 2 years.
7	Over 2 years up to and including 4 years.
8	Over 4 years up to and including 10 years.
9	Over 10 years.

[41]Ibid.

The eleven aptitude variables were used to measure the specific capacities and abilities required of an individual in order to learn or perform adequately a task or job duty. They were:

Variable 6 INTELLIGENCE: General learning ability. The ability to "catch on" or understand instructions and underlying principles. Ability to reason and make judgments. Closely related to doing well in school.

Variable 7 VERBAL: Ability to understand meanings of words and ideas associated with them, and to use them effectively. To comprehend language, to understand relationships between words, and to understand meanings of whole sentences and paragraphs. To present information or ideas clearly.

Variable 8 NUMERICAL: Ability to perform arithmetic operations quickly and accurately.

Variable 9 SPATIAL: Ability to comprehend forms in space and understand relationships of plane and solid objects. May be used in such tasks as blueprint reading and in solving geometry problems. Frequently described as the ability to "Visualize" objects of 2 or 3 dimensions, or to think visually of geometric forms.

Variable 10 FORM PERCEPTION: Ability to perceive pertinent detail in objects or in pictorial or graphical material; To make visual comparisons and discriminations and see slight differences in shapes and shadings of figures and widths and lengths of lines.

Variable 11 CLERICAL PERCEPTION: Ability to perceive pertinent detail in verbal or tabular material. To observe differences in copy, to proofread words and numbers, and to avoid perceptual errors in arithmetic computation.

Variable 12 MOTOR COORDINATION: Ability to coordinate eyes and hands or fingers rapidly and accurately in making precise movements with speed. Ability to make a movement response accurately and quickly.

Variable 13 FINGER DEXTERITY: Ability to move the fingers and manipulate small objects with the fingers rapidly or accurately.

Variable 14 MANUAL DEXTERITY: Ability to move the hands easily and skillfully. To work with the hands in placing and turning motions.

Variable 15 EYE-HAND-FOOT COORDINATION: Ability to move the hand and foot coordinately with each other in accordance with visual stimuli.

Variable 16 COLOR DISCRIMINATION: Ability to perceive or recognize similarities or differences in colors, or in shades or other values of the same color; to identify a particular color, or to recognize harmonious or contrasting color combinations, or to match colors accurately.[42]

The values assigned to each variable measures the degree of each aptitude the job requires for satisfactory (average) performance. The average requirements, rather than a maximum or minimum, were used. The amount required is expressed in terms of equivalent amount possessed by segments of the general working population.

The following scale was used to quantify the variables.

1. The top 10 percent of the population. This segment of the population possesses an extremely high degree of the aptitude.

2. The highest third exclusive of the top 10 percent of the population. This segment of the population possess an above average or high degree of the aptitude.

3. The middle third of the population. This segment of the population possesses a medium degree of the aptitude, ranging from slightly below to slightly above average.

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[42] Ibid.

4. The lowest third exclusive of the bottom 10 percent of the population. This segment of the population possesses a below average or low degree of the aptitude.

5. The lowest 10 percent of the population. This segment of the population possesses a negligible degree of the aptitude.[43]

The variables gathered from the DOT were used to solve the classification equations derived from the discriminant analysis. The solution to each equation specified which group the occupation belonged to by a simple classification scheme, called the minimum chi-square rule. This rule required the computing of chi-square values for the unclassified occupations with respect to each of the three groups. Each occupation was assigned to the group which yielded the smallest chi-square.

After the discriminant function was derived, it was applied to the 417 occupations used to project employment by census code. All 417 occupations were classified as either vocational,professional, or no skill occupations (see Appendix I, Table 5). Several of the occupations which were previously classified as appropriate for vocational education, as projected by MOTIS, were removed. The occupations which were classified as vocational were then used to project employment. All those excluded by the analysis

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[43]Ibid., p. 653.

were also removed from the Industrial/Occupational matrix used to project employment by MOTIS. Projected employment was then derived. The new projected occupational openings by USOE code are presented in Table 22. In total, over 207,813 projected openings were dropped from the MOTIS projections for the period 1976-1981. These modified projections were then used as the PO_j values in equations 1.1 and 2.1 of the linear and goal programming models discussed earlier.

TABLE 22

COMPARISON OF PROJECTED OPENINGS BY VOCATIONAL PROGRAMS
1976 - 1982

MOTIS Projections			Modified Projections		
01.00	Agriculture	48,122	01.01	Agriculture	35,284
04.00	Distributive	119,791	04.00	Distributive	57,673
07.00	Health	29,845	07.00	Health	13,401
09.00	Home Econ.	17,494	09.00	Home Economics	4,860
14.00	Office Occupations	123,730	14.00	Office Occupations	115,424
16.00	Technical	1,429	16.00	Technical	788
17.00	Trade and Industry	192,031	17.00	Trade and Industry	97,199
	Total	532,442		Total	324,629

Summary

In this chapter the use of multivariate statistics in the planning of vocational education in Missouri was illustrated. The use of such techniques offer many possibilities to the vocational education planner. The problems faced by the vocational education planner are inherently multivariate, that is, require the analysis of multiple independent and dependent variables. As more planners become familiar with the techniques they will no doubt find increased uses.

Although the purpose of this chapter was simply to illustrate the application of a multivariate technique, the problem to which the technique was applied was particularly relevant. The problem was the modification of projected employment so that the projections would reflect only those occupations which require vocational education.

CHAPTER IX

DECISION-MAKING SUPPORT SYSTEM: HEURISTIC APPLICATION

The last technique in the decision-making support system to be discussed in this report are those tools which can be classified as heuristic methods. The term heuristic as commonly used, refers to the use of a rigorous set of rules or guides to decision making. In this section a heuristic model that focuses on a basic problem in planning vocational education programs is illustrated.

Impetus for Needs Analysis

Determining the number of persons in need of vocational education services is one of the more difficult and long standing problems facing vocational education planners. The reason for determining those in need is hardly debatable. The 1976 Vocational Education Amendments specify that:[44]

> . . . funds are to be distributed by the state to eligible recipients on the basis of annual applications which describe the vocational education needs of potential students in the area or community served by the applicant and it must be indicated how, and to what extent, the program proposed in the application will meet such needs.

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[44]Education Amendments of 1976, 90 Stat. 2081, Public Law 94-482, 20 U.S.C. 2307 (1976).

Vocational education programs have seldom suffered from a lack of potential students. There has always been more persons in need of vocational education services than could be served by vocational education programs. Budgetary constraints, skepticism about the effectiveness of vocational education, and the inability to identify unfilled job openings have combined to restrict program levels and enrollments to a fraction of the total needs. This dilemma has no doubt inhibited the development of an approach to estimate the total need for vocational education services.

Historically, vocational education programs have focused on serving the secondary age school population. In the nation, as well as in Missouri, the majority of vocational education enrollments have been at the secondary level. In the future, the greatest demand for vocational services may be at the post-secondary or adult level. Without a method to monitor the vocational education needs of these various groups, the needs of some constituents may go unnoticed.

The Foundations of the Needs Analysis

The needs analysis was designed to meet several criteria. First, the method was designed to identify those groups of people to be served by vocational education as required by federal legislation. To paraphrase the 1976 legislation, persons of all ages in all communities of

the state, those in high school, those who are preparing to enter the labor market, those who need to have their skills upgraded, those with special educational handicaps and those in post-secondary schools should have ready access to vocational training. In addition this training has to be realistic in light of actual or anticipated opportunites for gainful employment.

Second, the technique was designed to allow for the fact that different levels of the vocational education system have distinct target groups of people to serve. For example, typical post-secondary programs are designed to provide specific skill preparation in occupations which require a higher level of educational preparation than programs at the secondary level. When compared to post-secondary programs, secondary programs are often broader in purpose. Many secondary programs meet a variety of needs such as career orientation, career exploration, serving special needs students, and specific skill preparation for entry level employment. The adult vocational programs differ as well. Adult programs are aimed at upgrading or retraining those persons who have already entered the labor force and are either employed or unemployed. Typically this group should be comprised of those persons who are having some labor market difficulty. A needs analysis, logically then, should reflect not only the groups that need vocational education services but the education that is best equipped to meet these needs.

Another factor which was considered in the design of the needs analysis is the relationship between vocational education and the labor market activity of individuals. Vocational education is designed to prepare individuals for entry, advancement, or continuation in an occupation. An individual's labor market activity, in turn, should indicate the existence of a need for vocational education services. For example, a person may be unemployed because of inadequate skills to secure or hold a job. In turn, the person may be underemployed due to insufficient skills required to move up the job ladder. Obviously, a methodology for determining those in need of vocational education should include measures that reflect the needs of those having labor market problems.

Still another element that was considered is that the need for vocational education services are dynamic. The technique was designed to allow for this dynamic or changing nature of needs. Those in need of vocational education services vary from point in time to another and from one community to another. For example, the vocational education needs of secondary students in a school district where 90 percent of its graduates go on to college are different than the needs of the secondary students in a community with a 24 percent reported unemployment rate and 5 percent of the youth going on to college. Clearly, the needs for vocational education services in a community are a function of the types of employment available, the industrial base, and other

economic factors. Although it would be much simpler to arbitrarily seek to serve a certain percent of secondary, post-secondary, or adults, to do so ignores the nature of needs. That is, that needs are dynamic. This idea contradicts the familiar so-called 80 percent argument whereby vocational education is provided for all those who do not go on to college.[45]

Another criterion that was considered in developing the methodology was vocational education's relationship to other agencies or institutions involved in the development of human resources. There are a variety of other agencies and institutions that must be considered in a needs analysis. These are depicted in Figure 10.

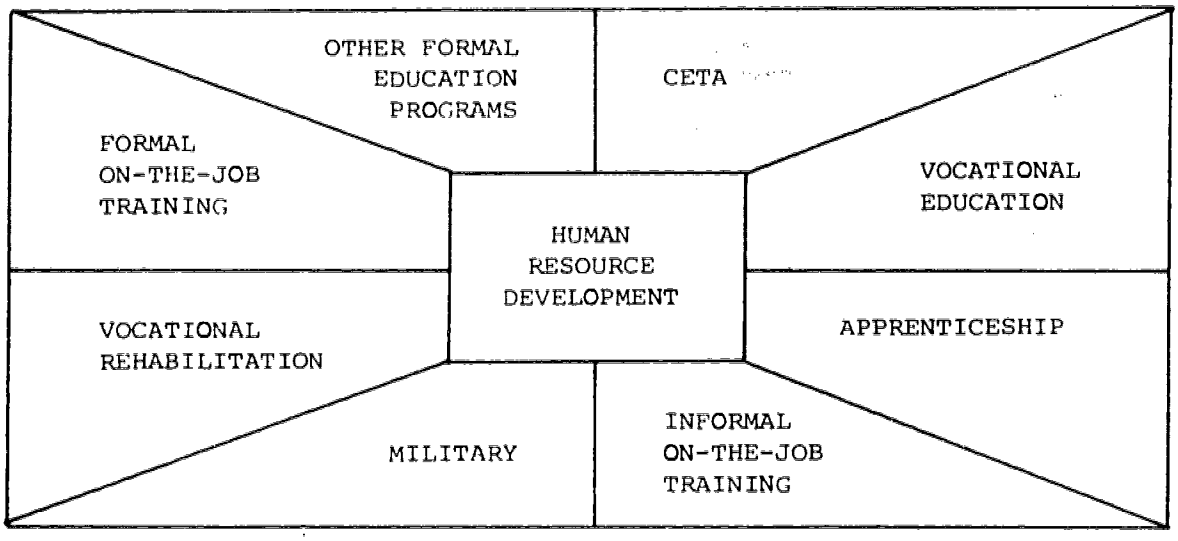

Figure 10

Human Resource Development Institutions

[45] Gerald B. Leighbody, Vocational Education in America's Schools--Major Issues of the 1970's. (Chicago, Illinois: American Technical Society, 1972) p. 5.

It is likely that there will be considerable overlap in the target groups of the agencies depicted in Figure 10. If the planner is not conscious of this overlap, considerable duplication is inevitable. A major weakness of the needs analysis as developed in this project was its failure to consider all of these institutions to the extent desired.

A final criterion was that of parsimony. The technique was designed to use existing data which have been collected by other agencies such as the Bureau of Census and the State Employment Security Offices. In addition, every attempt was made to simplify the technique so the analysis could be utilized without the aid of a computer.

The Method

The methodology as outlined on the following pages presents a systematic technique for estimating the need for vocational education services for planning purposes. The methodology identifies the number of persons in need of vocational education by secondary, post-secondary, and adult levels. The technique makes use of current Employment Service data on area unemployment, as well as population, labor force, and income data from the 1970 census, updated on the basis of current relationships developed from national labor force and poverty data. When available, more recent state or area data and relationships should be used in making these estimates.

The methodology, as depicted in Figure 11, is composed of three major parts--secondary, post-secondary, and adult. The methods used to identify those in need of vocational education services in each of these areas are explained next. There is a worksheet at the end of this chapter which may assist the reader in understanding the explanation.

High School Age Persons In Need of Vocational Education

The essence of determining high school age persons in need of vocational education services consisted of breaking this group into two target groups--a regular group and a special needs group. To derive the regular student target group a simple technique was used. The labor force participation rates of high school graduates were obtained for males and females. These rates were used as surrogates for the expected labor force participation of 11th and 12th grade students currently in high school. Changes in these rates over time reflect the shifts in labor force activity of both sexes in a particular labor market area. The technique monitors these changes and adjusts the size of the target group according to the labor force activity of former secondary school graduates. The planner has several options in arriving at these rates, he can simply use the previous years rates, he can use the rates as reported in the decennial census, or he can average previous years rates. In the application to Missouri, a smoothing averaging

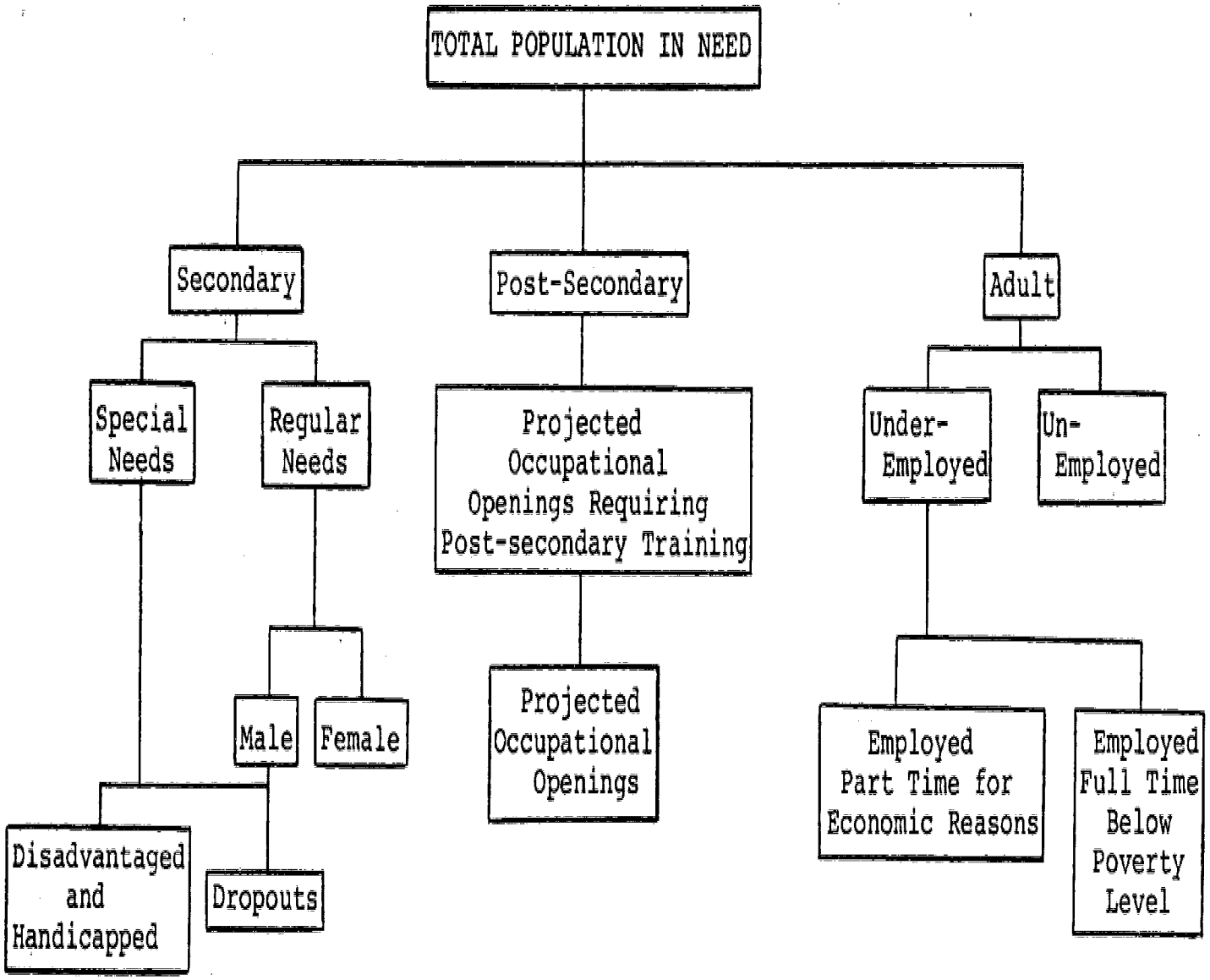

Figure 11

VOCATIONAL EDUCATION NEEDS ANALYSIS

method was used. After multiplying the projected enrollment in the 11th and 12th grades by these rates, the total number of regular vocational education students in need of vocational education is derived.

The number of special needs students in need of vocational education is derived by projecting the number of disadvantaged, handicapped, and potential drop-outs for the area in which the needs analysis is being conducted. Of course, these three subgroups are not necessarily mutually exclusive since some persons fit in all three categories. To eliminate this duplication each group was defined in a unique way. Potential dropouts included only 9th and 10th grade students. Actual dropouts are excluded. The rational being that once students become dropouts they are in the target group of adult vocational education programs. Of course, it is realized that many potential dropouts are in the 11th and 12 grades. By design of the methodology, they are counted in the numbers of regular students in need of vocational education and are not included in this category called potential dropouts.

The disadvantaged subgroup is estimated by multiplying the projected number of 11th and 12th grade students by the percent of that age group who are disadvantaged. This number is subtracted from the regular student category and added under the category of disadvantaged. Likewise, the handicapped subgroup is estimated by multiplying the

projected number of 11th and 12th grade age students by the percent of that age group who are handicapped. This number is then subtracted from the regular student category and added under the category of handicapped. The totals for the disadvantaged and handicapped categories over-estimate the number in these groups needing vocational education services since the technique considers all those who are handicapped or disadvantaged as being in need of services. Obviously, some of these students needs are met by the general or college-preparatory curriculum. Research has indicated that this over-estimate is negligible (less than 10 percent of those classified as disadvantaged or handicapped).

The total needs at the secondary level are then derived by adding together the number of regular students, the number of disadvantaged and handicapped, and the number of potential dropouts. This total reflects those in need of vocational services at a particular point in time. Since needs are dynamic, the needs analysis should be applied at regular intervals; logically before the preparation of the annual plan.

Post-Secondary Needs

The role of post-secondary vocational education has never been clearly articulated. There are some who perceive vocational education in post-secondary institutions as simply mirroring secondary vocational programs. That is, the curriculum offerings are essentially the same,

the difference simply being the ages of the target groups. In this sense, post-secondary education is remedial. It offers services to those who failed to obtain vocational preparation (assuming of course it was available) at the secondary level. On the other hand, some perceive post-secondary vocational education programs as a complement of secondary vocational education. The idea being that post-secondary education should focus on occupations that require higher levels of preparation than that typically available in the secondary school. In the first situation post-secondary vocational education may be in competition with secondary vocational education relative to the target groups. In the latter situation competition does not exist since the purpose of each level is different.

The Task Force 1990 study group in Missouri saw the competition and duplication of effort of secondary and post-secondary education as a serious problem.[46] Given this concern, the needs analysis for estimating secondary vocational education needs was designed to reflect the need for trained manpower in occupations which required post-secondary education. Thus, post-secondary education

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[46]Career and Adult Education (MDESE) and the Department of Practical Arts and Vocational-Technical Education, College of Education, A Project to Design, Develop and Test a Comprehensive Management Plan for Vocational Education in Missouri, TASK FORCE 1990, (Missouri: University of Missouri-Columbia, 1976).

in Missouri is thought to be a complement to secondary vocational education rather than in competition.

The starting point for determining the number of persons in need of post-secondary training is in the conversion of projected job openings by occupation to projected job openings by occupation and level. These projections by occupation and level are available for the 13 planning regions in the state. If the planning unit is the state or any combination of the 13 regions, then the planner can simply use the employment projections for the post-secondary level for that region. If the unit is smaller than the region, i.e. a local school district, then the matrix for that region can be used to convert industry employment to projected employment by level and occupation. Admittedly, this becomes quite tedious since it is possible, though not likely, to require over 200 multiplications. Although the methodology was not presented in the section on modifying employment projections, a technique was developed to convert projected openings to openings by level (i.e. secondary or post-secondary).

The technique is summarized briefly as follows: Multiple discriminant analysis is used to classify occupations as requiring secondary or post-secondary training. In many occupations, however, the difference between required preparation is not so great that the occupation could be classified as post-secondary or secondary. Thus it was necessary to weigh each occupation. The largest

weight that could be assigned was 1 which is interpreted to mean that the occupation cannot be entered unless post-secondary education is received. The smallest was zero which means no post-secondary education at all is required. The posterior probabilities for membership in the post-secondary group and secondary group are used as the weights. These values are then multiplied times the projected openings for each occupation. The procedure differentiates projected openings for each occupation by level. Given these openings, the vocational education planner can then ascertain the enrollment in each program by level necessary to fill the projected openings.

Estimation of Adult Needs

Clearly the concept of the need for vocational education services of the adult population should bear some relationship to the labor market experience of potential clients. Being unemployed, underutilized, or out of the labor force despite the need for a job is a starting point for defining need. Unfortunately, it appears that vocational education for adults is more accurately described as based on the avocational needs and interests of this target group. The result has often been to offer programs that are only remotely related to the labor market difficulty that the adult population in a given area is experiencing.

The failure to consider the needs of adults from a labor market perspective was found to exist in Missouri. The technique described in this section represents an attempt to reverse this approach and to present the needs of adults in relation to the labor market difficulty they are having. The technique identifies adults in the following groups:

1. Total individuals unemployed for 15 weeks or more
2. Total underutilized individuals with incomes at the near poverty level
3. Total individuals employed part-time for economic reasons
4. Total employed full-time but with incomes below the poverty level

These groups make up the adults who are in need of vocational education services.

One of the important characteristics of this technique is that it accounts for the dynamics of needs. For example, as the unemployment rate rises, increased needs are reflected in the needs analysis. Conversely, as unemployment falls, so does the number in need of services. A possible method to articulate these needs to the vocational education system is to have the unemployment service refer clients to the vocational education system in the above categories.

Perhaps the most challenging aspect of meeting the needs of adults is in the design of the delivery system. An adult delivery system, by nature, will require a great

deal of flexibility, responsiveness, and cooperation if the needs are to be met. Responsiveness in the sense that programs would have to be offered when the need exists which probably will not coincide with the calendar of the school year or the time most teachers are used to teaching. For that matter, the programs may not be located in the schools. It is possible that the most efficient setting might be the factory or business where the skills will be used. Flexibility in the sense that the programs are started when the need arises and terminated when the need no longer exists (even though the teacher may become unemployed!). Cooperation in the sense that workable arrangements are established between employers, other manpower programs, employment security offices, and the vocational education system.

Application of Needs Analysis

The worksheets that follow summarize the basic steps for estimating the number of persons in need of vocational education services. Specific instructions for completing the items in the worksheet are not presented in this report. Further information can be obtained from the Research Team at the University of Missouri-Columbia.

It is important to reiterate that the needs analysis can be used for estimating needs at the local, regional or state level. The numbers in this example were derived in a needs analysis for the State of Missouri. The totals for

each group (secondary, post-secondary, and adult) were then used in establishing goals for the number of persons to be served by vocational education.

Part A: High School Age Students In Need Of Vocational Education.

LINE			
1	1.	Total projected enrollment in grades 9-12 for projection year 76	284,893
2		a. Projected male enrollment in grades 11-12 for 76	71,223
3		b. Projected female enrollment in grades 11-12 for 76	71,223
4	2.	Total population age 16-19 - 1970	340,919
5		a. Total males age 16-19 for 1970	172,305
6		b. Total males age 16-19 projected for 76	182,224
7		c. Total females age 16-19 for 1970	168,614
8		d. Total females age 16-19 projected for 76	177,054
9	3.	Labor force participation of target groups (11 & 12th grades)	
10		a. Total number of males 18 & 19 years old - 1970	83,370
11		b. Total 18 & 19 year old males in civilian labor force	44,643
12		c. Labor force participation of 18 & 19 year old males (line 11 divided by line 10)	.54
13		d. Total number of females 18 & 19 years old - 1970	82,998
14		e. Total 18 & 19 year old females in the civilian labor force	40,683
15		f. Labor force participation of 18 & 19 year old females (line 14 divided by line 13)	.49

LINE			
16	4.	Labor force participation of target groups (11 & 12 grade drop outs).	
17		a. Total 16-17 age males employed full-time - 1970	5,685
18		b. Total 16-17 age males unemployed - 1970	4,119
19		c. Total of employed full-time & unemployed males age 16-17 (add lines 17 & 18)	9,804
20		d. Percent of pop. age 16-19 that are males and age 16-17 and employed full-time or unemployed in 1970 (line 19 divided by line 5)	.056
21		e. Projected number of 16-17 age males needing voc. ed. for 1975 (line 6 x 20) (Surrogate for drop-outs)	10,204
22		f. Total 16-17 age females employed full-time - 1970	2,651
23		g. Total 16-17 females unemployed - 1970	2,763
24		h. Total of employed full-time & unemployed females age 16-17 (add lines 23 and 24)	5,414
25		i. Percent of pop. age 16-19 that are females and age 16-17 and employed full-time or unemployed in 1970 (line 24 divided by line 7)	.032
26		j. Projected number of 16-17 age females needing voc. ed. Results for 1975 (line 8 x line 25) (Surrogate for drop-outs)	5,665
27	5.	Total number of high school age students in need of vocational education services.	
28		a. Total number of 11 & 12th grade males in need of services (line 2 x line 12)	28,460
29	6.	Total number of potential dropouts, disadvantaged, and handicapped.	
30		a. Total number of potential dropouts (enter line 21) male	10,204

LINE			
31	b.	Total number of 11 & 12th grade females in need of services (line 3 x 15)	34,899
32	c.	Total number of potential female drop-outs (enter line 26)	5,665
33	d.	Percent of age group estimated as disadvantaged 15%	15%
34	e.	Total number of disadvantaged to serve (line 28 x line 33)	4,039
35	f.	Percent of age group known to be handicapped 4%	4%
36	g.	Total number of handicapped to serve (line 28 + line 31) x (line 35)	2,834
37	h.	Total disadvantaged and handicapped	6,873
38	i.	Adjusted number of regular 11 & 12th grade students (line 28 + line 31) - (line 37)	66,486
39	7.	Total needs to be met	
	a.	Total needs to be met at secondary level (sum lines 30, 32, 37, 38)	89,228

Part B: Post-Secondary Vocational Education Needs

Computer Programmers	624
Computer Specialists	1514
Farm Management Advisors	46
Foresters and Conservationists	340
Laboratory Technicians	244
Health Record Technologists	870
Radiologic Technologists	139
Health Technologists N.E.C.	638
Agriculture Technicians	125
Chemical Technicians	40
Embalmers	14
Financial Managers	730
Buyers and Shippers, Farm Products	144
Retail and Wholesale Sales	3424
Funeral Directors	142
Transportation	4131
Restaurant Managers	839
Sales Managers Except Retail	349
Advertising Agents	375

Part B (cont.)

Real Estate Agents	1391
Stock and Bond Salesmen	730
Real Estate Appraisers	130
Foremen Industry	2571
Data Processing Repair	63
Millers	144
Inspectors, Manufacturing	145
Tailors	228
Farmers (Owners and Managers)	4703
Dental Assistants	134
Health Assistants (Other)	630
Hairdressers and Cosmetologists	1575
Firemen	340
Law Enforcement	4685
Hotel and Lodging	396
Insurance	1358
Practical Nurses	881
TOTAL	35,280

Part C: Adults In Need of Vocational Education

LINE			
1	1.	Total Employment - 16 years and older	1,845,402
2		a. Annual average unemployment rate 4.2	4.2
3		b. Total unemployment	77,506
4	2.	Underutilized individuals needing employment-related assistance	
5		a. Employed part-time for economic reasons - Total employed - 1970	
6		b. 1970 annual average total employed	1,845,402
7		c. 1976 annual average employed part-time (line 6 times 2.7%)	381,998
8		d. Total employed part-time for economic reasons	57,293
9	3.	Employed full-time but with family income at or below poverty level	
10		a. Total families in state or area, 1970	379,923

Part C (cont.)

LINE			
11	b.	Total low income families, 1970	49,756
12	c.	Percent change in total population since 1970	6%
13	d.	Total low income families line 11 x line 12 + line 11 (for the current period)	67,284
14	e.	Line 13 times appropriate region, state or area factor (22.4%)	15,071
15	f.	Total family head at or below the poverty level (rewrite line 14)	15,071
16	g.	Total number of unrelated individuals in state or area, 1970	85,628
17	h.	Number of low income unrelated individuals in state or area, 1970	48,886
18	i.	Line 17 times factor of 5.0%	2,444
19	j.	Total unrelated individuals at or below poverty level	2,444
20	k.	Total employed full-time but with income below the poverty level (sum lines 19 and 15)	17,515
21	l.	Sub-total underutilized individuals needing employment-related assistance (sum of lines 20 and 8)	74,808
22	4.	Estimates of those employed workers in near poverty	
23	a.	Workers employed full-time but with family income at the near-poverty level line 10 times factor of 22.4%	85,102
24	b.	Unrelated individuals with income at near poverty level and employed full-time. (Line 16 x factor of 5%)	4,281

Part C (cont.)

LINE			
25		c. Subtotal of other underutilized individuals with family incomes at the near poverty levels (sum lines 23 and 24)	89,383
26		d. Total underutilized with incomes at the near poverty level (repost line 25)	89,383
27	5.	Individuals that have been unemployed for 15 weeks or more	
28		a. Total unemployment (repost line 3)	77,506
29		b. Line times the per cent of persons unemployed for 15 weeks or more (current factor 24.4%)	18,911
30	6.	Calculation of Adults needing vocational education	
31		a. Total individuals unemployed for 15 weeks or more (repost line 29)	89,911
32		b. Total underutilized individuals with incomes at the near poverty level (repost line 26)	89,383
33		c. Total individuals employed part-time for economic reasons (repost line 8)	57,293
34		d. Total employed full-time but with incomes below the poverty level (repost line 20)	17,515
35		e. Total adults in need of vocational education (sum lines 31, 32, 33 and 34)	183,102

SECTION III

IMPROVING VOCATIONAL EDUCATION PLANNING

CHAPTER X

IMPROVING VOCATIONAL EDUCATION PLANNING: MORE MYTH THAN REALITY?

The purpose of this chapter is to return to the rhetorical question posed in the title of this report. Specifically, the goal of this project was to seek an answer to this question by designing, applying, and implementing a vocational education planning system in Missouri. The goal was partially met by successfully designing and illustrating the application of a rational system for the planning of vocational education in Missouri. The details of the design and application of the system are described in the previous chapters.

The system as designed has not been implemented. The process, the tools, and the techniques have not been adopted for continued use by the State Department of Elementary and Secondary Education. Developmental activities and implementation attempts suggest that a reason for the lack of adoption stems from a resistance to improve the planning process. The reasons underlying this resistance must be explored if the planning of vocational education is to be improved. A logical way to proceed is to identify and analyze barriers that stand in the way of improving the planning process. Once this is done this report returns to

the rhetorical question: Is the improved planning of vocational education more myth than reality?

Barriers to Improved Planning

In this section three barriers to improving the process of planning vocational education are discussed. These barriers may help to explain some of the reasons why efforts to improve the planning of vocational education in Missouri as well as in other states have met resistance. It is anticipated that these explanations will provide insight to those who are planning to conduct developmental research projects of this nature in other settings. The barriers discussed are: (1) disincentive to plan, (2) the existence of a laissez-faire educational system, and (3) inadequately trained administrators.

Disincentive to Plan

Why hasn't the planning of vocational education been improved already? Congress, advisory councils, critics, and scholars have pointed out the need for improved planning. Repeatedly, the topic has been discussed. Legislation dealing with the issue has been passed time and again. Most recently, the 1976 legislation established specific steps that states must follow in the planning of vocational education. The incentive is there or is it? State planning grants in the 1976 legislation amount to $25 million dollars. Yet, state administrators insist they need additional money to do the planning mandated by the legislation.

Ideally, improved planning should not be something that is forced on state education agencies. It seems that the benefits of planning, particularly when it results in the improved delivery of vocational education, should be incentive enough. Alas, isn't this a naive assumption?

In fact don't vocational education administrators in state education agencies behave as they do because they perceive it to be in their best interest to act as they do? In a classical work on vocational education planning Stevens made this point:

> We conclude from this that there is a need to eschew reliance on beliefs in inherent good intentions, to end repetitive appeals for improved communication, and to halt the stream of recommendations to collect more or better information on this and that aspect of our lives. The actors behave as they do because it is in their self-interest to do so, given the institutional context in which they operate. Given the rules of the game, everyone plays to win.[47]

Why is it not in their interest to plan? Perhaps the prevailing belief that planning constitutes a threat to the existing educational establishment is the answer. This belief is held not only by several administrators at the state level but also by many vocational teachers, teacher-educators, and vocational administrators in local schools and colleges. Planning appears as a threat because these groups have a vested interest in seeing that the existing balance and mix of programs are maintained. Planning is

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[47] David W. Stevens, Employment Projections for Planning Vocational-Technical Education Curricula: Mission Impossible? (Columbia, Missouri: Human Resources Research Program, University of Missouri-Columbia, 1976).

identified with change and programs can mean a loss of jobs and a shift in the distribution of resources. Unfortunately, these groups have been successful in exerting pressure to maintain the status quo. They have been effective in protecting their interests and have succeeded in slowing if not preventing change which they perceive as threatening.

Although state administrators may recognize the need to change, they are reluctant to do so because of the political pressure that these groups exert. Given this situation, there is a disincentive to plan. Logically, then, this dampens the incentive to improve the planning process.

Viewed from this perspective, the vocational education system is responding to the needs of the educational establishment and not the needs of those the system is designed to serve. The state administration is responding to those who have the loudest voice. Historical evidence verifys that teacher organizations have been one of the stronger lobbying groups in state politics. Vocational education constituents are poorly organized if at all. Obviously, the administration should be responsive to the public's needs since public support can only be justified if vocational education benefits students.

The Existence of a Laissez-Faire Educational System

A frequently heard argument against improved planning at the state level has been the idea of the existence of a

laissez-faire educational establishment. The idea explicit in such an arrangement is that local autonomy should prevail. Thus, an interventionist policy by the state department of education is undesirable. This idea has prevailed even though the behavior of the state regarding local autonomy would indicate the existence of a different type of relationship. Nevertheless, the concept of local autonomy is used to discourage the intervention of state education agencies in the planning of vocational education programs. The argument is that state and federal government contribute such a small amount (20 to 30 percent) toward the total cost of vocational education that they should exert very little control. Thus, the absence of control makes it absurd to think that state education agencies should influence the planning of vocational education at the local level.

The argument is faulty. To begin with, the philosophy of laissez-faire does not describe the state-local relationship. For some decades now the state and federal presence in vocational education has existed. The state's role does not reflect a "hands off" policy. The state's role is more accurately called ministrant in that it affects every aspect of the vocational education system at the local level: it certifys vocational teachers, it reimburses salaries and expenses, it buys equipment, it builds school facilities, and it supports the teacher education programs. Without approval, a single dollar of state and federal money

cannot be spent in a school district. Thus, a laissez-faire educational establishment is not consistent with reality.

Even if the principle of local autonomy prevailed, it cannot be used as an excuse to not improve the planning at the state level. In a narrow sense, the argument can be made that states have to be accountable for the state and federal dollars over which they have control. If local education agencies want to continue to support obsolete and irrelevant vocational programs, then they are entitled to do so. However, the state should not subsidize such programs with state and federal funds. The point is that regardless of local-state relationships the states cannot abdicate their responsibility to be accountable.

Even though the idea of a "hands off" policy does not depict reality, let us assume for a moment that it does. If the state administration refuses to coordinate or exercise control over the vocational programs throughout the state, then what function do they provide? Why is their presence needed? It is logical to suggest that their presence is not needed. It would be more efficient, given an anti-interventionist policy, to allocate the funds directly to the local education agencies. In Missouri it is estimated that approximately 3.5 to 4 million dollars could be saved by such action. Thus, even if a laissez-faire or "hands off" policy is tenable, its advocates do not pursue it to its logical consequences.

The most forceful argument against a laissez-faire policy is based on the nature of the problems which vocational education is asked to solve. Vocational education is concerned with the training of skilled manpower. In short, the nature of the manpower problems which vocational education is designed to minimize transcend school districts and political boundaries. The needs of labor markets on which the delivery of vocational education is based usually involve several school districts. Without central planning and coordination, duplicated and inefficient program delivery is bound to occur. Therefore, an effective vocational education system requires a strong central administration that is able to balance the interests of local education agencies so that the greatest good is accomplished for all.

Inadequately Trained Administrators?

There is an idea that permeates the thinking in professional education regarding the skills and experiences required of an educational administrator. The idea as it applies to vocational education is that the vocational administrator, to be successful, must have had experience as a teacher at the secondary level and also be able to be vocationally certified in a given occupational area. This idea manifests itself in the legislation and in state plans.

Why is the idea subject to questioning? Because the skills and experience gained in teaching are not the skills or experiences necessary to administer vocational education programs. The skills that are needed are administrative

skills, dealing with managing, planning, organizing, and controlling large and complex organizations. These skills are not learned as a teacher.

Many other institutions recognize that the skills of administrators are unique. Research and experience has convinced the health professions that medical doctors do not necessarily become competent hospital administrators. In fact, the vast majority of hospitals are managed by professional administrators not doctors, even though the purpose of the hospital is medical care. Of course the trend in industry for quite sometime has been to employ professional administrators to manage. The same idea applies to vocational education: the most competent administrators should be those who are trained as administrators; teaching experience as a prerequisite has not been conclusively demonstrated.

What problems does this idea and its practice cause? For one, it serves as a barrier to many competent and able administrators who are interested in working in vocational education. For another, this practice restricts the size of the pool of administrative talent, thus decreasing the number of individuals who are likely to have the necessary skills. And finally, the practice serves to isolate vocational education from some of the more innovative administrative practices being applied in business, industry,and other public agencies. In turn, the performance of vocational education suffers.

The planning model and the decision making support system presented in this report reflect some of the more

innovative tools available to the vocational education administrator today. If they are to be used, then vocational administrators must be trained in their use and operation. In other words, the use of these tools require personnel with knowledge and training in operations research, economics, and management. Such personnel will have to be made part of vocational education administration if these tools are to be effectively utilized.

Opening vocational education to other disciplines is not the only answer. Departments of vocational education personnel development in universities and colleges must also establish programs that prepare individuals to be professional administrators. The ramifications of the past practice of not training vocational education administrators to manage and of establishing artificial barriers to administrators from diverse backgrounds has added to the creation of an administrative crisis in vocational education.

The Lack of Administrative Responsibility

From the foregoing analysis it can be seen that a major barrier to the improved planning of vocational education is, in part, due to the lack of responsiveness on the part of vocational education administrators. The existence of disincentives to plan, a laissez-faire approach to administration, and the lack of trained administrators interact with other factors to create this dilemma. In this section the role of administrative responsiveness in the

administration of vocational education is examined. In the process the direction vocational education administration should take in the future is suggested.

Administrative responsiveness in government is a necessity in a democracy. Indeed, the first requisite of administration is responsibility. In fact, if the administration is responsible then responsiveness of the institution should be guaranteed.

There are essentially two ways of guaranteeing administrative responsibility in vocational education or in any other public institution for that matter. The first is to depend upon the administration's sense of responsibility. This approach, of course, is largely unsanctioned in that it is based on the administrator's deference or loyalty to the public. In contrast, there is the idea that responsibility must be sanctioned. As Finer maintains "responsibility cannot go unsanctioned it must be guaranteed by an arrangement of correction and punishment even up to the dismissal both of politicians and officials."[48] It is this latter view that has been mandated for vocational education. In short, vocational education legislation clearly establishes that the administration of vocational education should not determine its own course. Instead, administration must be responsible to the elected representatives of the public and, when

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[48]Herman Finer, "Administrative Responsibility in Democratic Government," Public Administration Review Vol. I (Summer, 1941), pp. 335-350.

appropriate, the public directly. This, of course, was the explicit idea underlying the strategic planning process depicted in the planning model. No doubt the control that the public exerts over administration will be limited by "technical feasibility." In other words, the planning which has been classified as administrative planning lies within an area that is not technically feasible for the public or their representatives to accomplish. And herein lies the only legitimate domain of the vocational education administrator.

What happens when administrative responsibility or power goes unchecked? Roughly three things can happen. Administration may become guilty of nonfeasance, that is, administration does not conform to the requirement of law or custom. This may be due to laziness, ignorance, or want of care for their charges, or in extreme cases corrupt influence. Second, there may be malfeasance, where administration carries out duties, but with waste and damage because of ignorance, negligence, or technical incompetence. Third, administration may be guilty of overfeasance resulting from a dictatorial temperment or a genuine public-spirited zeal.

How can an institution like vocational education that is in essence a public monopoly be made more responsive. Certainly we can reflect on the merits of competitive industry. In business the consumer can cast a vote daily for the producer by buying or not buying his goods or services. But in public monopolies the consumer is subject to the coercive

side of monopolies which seeks to maintain its own interests at the expense of the public it is to serve. Consequently, to overcome the potential evils flowing from public monopolies controls must be established.

The principal bodies that exert controls in vocational education are: legislatures, advisory councils, and boards of education. These bodies, serving to check administrative behavior, have the responsibility of representing the public's interest regarding the delivery of vocational education.

Although this control exists, there has evolved some loopholes that allow for administrative discretion. First, the legislation that describes the powers and duties of administrators may not be precise because the legislature was not clear in its mandate. Second, the legislative process is so handicapped by antiquated procedures that it is possible that the body cannot be relied on to remedy, punish, or correct inadequacies that exist in the administration of vocational programs. Third, there is apt to be a misunderstanding by the legislature and other bodies regarding the technical issues and jargon that are a part of the vocational education system. All of these loopholes allow administration to dodge responsibility and in some instances do as they please.

Conclusion

There is every indication that these loopholes are disappearing. The U.S. Congress in 1976 passed legislation

that was very prescriptive. The administrators' responsibility in the planning and evaluation of vocational education leaves less room for discretion. In a larger sense the public is demanding that vocational education become accountable. For too long, money has been spent on vocational education programs with limited knowledge of the benefits of such programs. The 1976 legislation and the public's demand for accountability should be omens to vocational education administrators. Evidence indicates that the sanctions exercised by the public are being enforce more emphatically. The devices of securing responsiveness are working; the procedure of criticism, debate, questioning and fact-finding are intact. In short, the incentive exists, more than ever before, for vocational administrators to be responsive.

Inasmuch as improved planning will improve administrative responsiveness the challenge is there. The answer then as to whether or not the improved planning of vocational education is more of a myth than a reality does not lay here. It can become either one. The answer is up to those who are responsible for the leadership and administration of vocational education. The system described in this report should improve the planning of vocational education. However, the implementation of such a system will require the commitment of state level administration.

APPENDIX I

DATA GATHERING AND ANALYSIS

APPENDIX I

DATA GATHERING AND ANALYSIS

This Appendix describes the process by which the data that were needed for applying the analytical techniques of the decision making support system were gathered and analyzed. The importance of these data cannot be overemphasized for the techniques are only as valid as the data that are used in their application. Existing data, descriptive of Missouri's system of vocational education, were found to be generally inadequate for use in the decision making support system. Some of the specific data required were not available. Some of the data that were available lacked sufficient accuracy to be usable.[49] In the sections that follow, the inadequacy of these data are specified. When appropriate, recommendations to minimize these inadequacies are offered. By necessity, however, these recommendations are limited to their direct effect on the application of the decision making support system to planning in vocational education.

Projecting Occupational Employment

In the linear and goal programming applications data were needed on projected occupational openings for the State of Missouri. The most logical source for these data was the Missouri Occupational Training Information System (MOTIS) which, among other things, was designed to

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[49] Missouri Department of Elementary and Secondary Education, Research Coordinating Unit, MOTIS Employment and Job Openings Projections: 1975-1981 (Jefferson City, Missouri 1975).

project occupational employment for use by vocational education planners.[50] These projections, however, proved to be inadequate. To secure usable projections, it was necessary to make revised projections by modifying the methodology employed in the MOTIS system. The steps required to modify these projections were presented in Chapter VIII.

Program Costs and Expenditures

Program Cost

Program cost data on vocational education programs have not been gathered by the Missouri Department of Elementary and Secondary Education.[51] Therefore, it was necessary to use program cost data from other states as proxies for the cost of vocational education programs in Missouri. Obviously, the cost estimates of vocational education programs in other states are not the same as the costs of vocational programs in Missouri. However, it was not feasible to gather program cost information for the State of Missouri as a part of this study; therefore, the investigator elected to use substitute costs generated by other states. The cost estimates used were from Ohio[52] and Florida.[53] A comparison of

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[50]Missouri Department of Elementary and Secondary Education, Research Coordinating Unit, MOTIS Technical Report, by James Pershing and Richard Tiller (Jefferson City, Missouri, 1973).

[51]Charles Henry, Director of Finance Division of Career and Adult Education, Missouri Department of Elementary and Secondary Education, Jefferson City, Missouri, September 14, 1976.

[52]Ohio Department of Education, A System for Analyzing the Cost of Operating Vocational Education Programs at the Secondary Level in Ohio (Columbus, Ohio: Ohio Department of Education, 1975).

[53]Institute for Education Finance, Costs of Vocational and Adult Education Programs in Florida (Florida: Institute for Educational Finance, College of Education, University of Florida, 1975).

the cost estimates for the two states indicated that they were quite similar. Thus, the generalization of these costs to the vocational education program in Missouri was judged to be reasonable and would not result in a distortion of the results of the applications of the linear and goal programming models.

Program costs, for those occupations identified as appropriate for secondary vocational education, are listed in Table AI-6. The table presents the annual cost per enrollee of each program. For purposes of the linear and goal programming models, data were needed on cost per completer. This was derived by multiplying the length of the program times the cost per enrollee after making an adjustment for dropouts (Table AI-6). These cost estimates were used in the applications of linear and goal programming and are represented in the model by the C_j coefficients in the budget constraint equations (1.4 and 2.4). The cost of vocational programs will no doubt vary from one region of the state to the other, but because of inadequate date, the programs were assumed to be of equal cost throughout the state.

Expenditures on Vocational Education

How much is actually spent is unknown. The latest records of expenditures revealed that over $45 million of state and federal monies were spent on vocational education.[54] The amount spent by local school districts is unknown. The data have never been gathered. Estimates by the Director of Finance for the Division of Career and Adult Education (MDESE) place the local expenditures between 50-70 percent of total funds spent on vocational education.[55]

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[54] Charles Henry, op. cit. [55] Ibid.

In the application of the linear and goal programming models, the local expenditures had to be estimated. To do so, the average cost of training a student in a program was multiplied by the enrollment in that program area and then summed over all programs in the state. The estimates of total funds spent are presented in Table AI-7. These values are employed in the budget constraints in the linear and goal programming models and are represented by the coefficients in the budget constraint equations. The budget constraint was set at $75,727,550 for the 1975-76 school year. This estimate excludes expenditures on consumer home economics and pre-vocational programs in the state.

Other Program Data

Placements, Disadvantaged, LFPR, Continuing Education

The number of students who were placed in training related jobs, who were classified as disadvantaged, who were in the labor force, and who were continuing their education after completing vocational programs were compiled from MOTIS computer tapes for the 1974-1975 school year. These data were then converted to percentages which reflected proportions of program completers from each program classified according to the four categories. The decimal equivalents of these percentages were used as the P, D, LFPR, and BS coefficients in the linear and goal programming models (refer to equations 1.1 & 2.6, 1.5 & 2.5, 1.7 & 2.7, 1.09 & 2.09 respectively). (Table AI-10)

Enrollments

Total public school enrollments for grades 9-12 for the state were 326,083 in school year 1975-1976. This level of enrollment

based on a study of Missouri Public Schools Enrollment by Grade from 1968-1990.[56] This enrollment level was used as constraint (PE) in constraint equation (2.3). The constraint simply limits vocational enrollments to 50 percent of the secondary school enrollment grades 11-12.

Table AI-8 provides historical and projected enrollment data by grade through 1990. The projections are based on actual and predicted birth rates as well as historical relationships between enrollment in one grade in a given year and in the next grade the following year.

Wage and Salary

Wage and salary data were secured from the 1975-1976 Occupational Outlook Handbook for each occupation for which vocational education programs provide training.[57] The data in Table AI-8 were checked against wage and salary data collected by Roskam (1975) in a study of "Labor Market Analysis and Educational Planning."[58] These data were not used in the constraint to specify entry wages of vocational education completers since the applicability of the data were questionable.

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[56] Career and Adult Education (MDESE) and the Department of Practical Arts and Vocational-Technical Education, College of Education, A Project to Design, Develop and Test a Comprehensive Management Plan for Vocational Education in Missouri, TASK FORCE 1990, (University of Missouri-Columbia, 1975).

[57] U.S. Department of Labor, Bureau of Labor Statistics, Occupational Outlook Handbook.

[58] Alan Roskam, Labor Market Analysis and Educational Planning: A Test of the Competitive Hypothesis (Missouri: University of Missouri-Columbia, 1975).

Ideally, a vocational education follow up system would provide data on entry level wages of vocational graduates. Such a system would not be difficult to develop in Missouri. Once the wage and salary data were collected, cost benefit analysis techniques would easily be applied. Then, the economic benefits of vocational education programs could be established with greater certainty than exists at the present time.

Summary

This Appendix describes the sources and modifications of data that were required to utilize the tools and techniques of the decision making support system. Since data on vocational education programs in Missouri are scarce and inadequate, changes are suggested and data improvements made in several areas.

In particular, a technique had to be developed whereby projected employment could be modified so that the data would be more usable. In addition, reasons for gathering program expenditures, program costs, and wages and salaries of graduates were expressed. Most importantly, this Appendix underscored the fact that vocational education program information needs to be improved. While planners and decision makers can make use of the analytical techniques of the decision making support system by modifying data the certainty of the results will improve as more accurate information is made available. This is simply one more situation where the improved planning of vocational education depends upon administration's willingness to adopt procedures that insure that accurate and timely data are available before planning begins.

Contained in the remainder of this appendix are the tables referenced in previous chapters.

TABLE AI-1

OCCUPATIONAL CLASSIFICATION SYSTEM

Equivalent alphabetic codes follow some codes. Either code may be utilized, depending on the processing method. "n.e.c." means "not elsewhere classified."

Occupation Code	Professional, Technical and Kindred Workers
001	Accountants
002	Architects
	Computer specialists
003	Computer programmers
004	Computer systems analysts
005	Computer specialists, n.e.c.
	Engineers
006	Aeronautical and astronautical engineers
010	Chemical engineers
011	Civil engineers
012	Electrical and electronic engineers
013	Industrial engineers
014	Mechanical engineers
015	Metallurgical and materials engineers
020	Mining engineers
021	Petroleum engineers
022	Sales engineers
023	Engineers, n.e.c.
024	Farm management advisors
025	Foresters and conservationists
026	Home management advisors
	Lawyers and judges
030	Judges
031	Lawyers
	Librarians, archivists, and curators
032	Librarians
033	Archivists and curators
	Mathematical specialists
034	Actuaries
035	Mathematicians
036	Statisticians
	Life and physical scientists
042	Agricultural scientists
043	Atmospheric and space scientists
044	Biological scientists
045	Chemists
051	Geologists

(continued)

TABLE AI-1 (Continued)

Occupation Code	Professional, Technical and Kindred Workers
052	Marine scientists
053	Physicists and astronomers
054	Life and physical scientists, n.e.c.
055	Operations and systems researchers and analysts
056	Personnel and labor relations workers
	Physicians, dentists, and related practitioners
061	Chiropractors
062	Dentists
063	Optometrists
064	Pharmacists
065	Physicians, medical and osteopathic
071	Podiatrists
072	Veterinarians
073	Health practioners, n.e.c.
	Nurses, dietitians, and therapists
074	Dietitians
075	Registered nurses
076	Therapists
	Health technologists and technicians
080	Clinical laboratory technologists and technicians
081	Dental hygienists
082	Health record technologists and technicians
083	Radiologic technologists and technicians
084	Therapy assistants
085	Health technologists and technicians, n.e.c.
	Religious workers
086	Clergymen
090	Religious workers, n.e.c.
	Social scientists
091	Economists
092	Political scientists
093	Psychologists
094	Sociologists
095	Urban and regional planners
096	Social scientists, n.e.c.
	Social and recreation workers
100	Social workers
101	Recreation workers
	Teachers, college and university
102	Agriculture teachers
103	Atmospheric, earth, marine, and space teachers
104	Biology teachers
105	Chemistry teachers
110	Physics teachers
111	Engineering teachers

(continued)

TABLE AI-1 (Continued)

Occupation Code	Professional, Technical and Kindred Workers
112	Mathematics teachers
113	Health specialties teachers
114	Psychology teachers
115	Business and commerce teachers
116	Economics teachers
120	History teachers
121	Sociology teachers
122	Social science teachers, n.e.c.
123	Art, drama, and music teachers
124	Coaches and physical education teachers
125	Education teachers
126	English teachers
130	Foreign language teachers
131	Home economics teachers
132	Law teachers
133	Theology teachers
134	Trade, industrial, and technical teachers
135	Miscellaneous teachers, college and university
140	Teachers, college and university, subject not specified
	Teachers, except college and university
141	Adult education teachers
142(N)	Elementary school teachers
143	Prekindergarten and kindergarten teachers
144	Secondary school teachers
145	Teachers, except college and university, n.e.c.
	Engineering and science technicians
150	Agriculture and biological technicians, except health
151	Chemical technicians
152	Draftsmen
153	Electrical and electronic engineering technicians
154	Industrial engineering technicians
155	Mechanical engineering technicians
156	Mathematical technicians
161	Surveyors
162	Engineering and science technicians, n.e.c.
	Technicians, except health, and engineering and science
163	Airplane pilots
164	Air traffic controllers
165	Embalmers
170	Flight engineers
171	Radio operators
172	Tool programmers, numerical control

(continued)

TABLE AI-1 (Continued)

Occupation Code	Professional, Technical and Kindred Workers
173	Technicians, n.e.c.
174	Vocational and educational counselors
	Writers, artists, and entertainers
175	Actors
180	Athletes and kindred workers
181	Authors
182	Dancers
183	Designers
184	Editors and reporters
185	Musicians and composers
190	Painters and sculptors
191	Photographers
192	Public relations men and publicity writers
193	Radio and television announcers
194	Writers, artists, and entertainers, n.e.c.
195	Research workers, not specified
201	Assessors, controllers, and treasurers; local public administration
202	Bank officers and financial managers
203	Buyers and shippers, farm products
205	Buyers, wholesale and retail trade
210	Credit men
211	Funeral directors
212	Health administrators
213	Construction inspectors, public administration
215	Inspectors, except construction, public administration
216	Managers and superintendents, building
220	Office managers, n.e.c.
221	Officers, pilots, and pursers; ship
222	Officials and administrators; public administration, n.e.c.
223	Officials of lodges, societies, and unions
224	Postmasters and mail superintendents
225	Purchasing agents and buyers, n.e.c.
226	Railroad conductors
230	Restaurant, cafeteria, and bar managers
231	Sales managers and department heads, retail trade
233	Sales managers, except retail trade
235	School administrators, college
240	School administrators, elementary and secondary
245	Managers and administrators, n.e.c.

(continued)

TABLE AI-1 (Continued)

Occupation Code	Sales Workers
260	Advertising agents and salesmen
261	Auctioneers
262	Demonstrators
264	Hucksters and peddlers
265	Insurance agents, brokers, and underwriters
266	Newsboys
270	Real estate agents and brokers
271	Stock and bond salesmen
280	Salesmen and sales clerks, n.e.c.[1]

Occupation Code	Clerical and Kindred Workers
301	Bank tellers
303	Billing clerks
305(P)	Bookkeepers
310	Cashiers
311	Clerical assistants, social welfare
312	Clerical supervisors, n.e.c.
313	Collectors, bill and account
314	Counter clerks, except food
315	Dispatchers and starters, vehicle
320	Enumerators and interviewers
321	Estimators and investigators, n.e.c.
323	Expediters and production controllers
325	File clerks
326	Insurance adjusters, examiners, and investigators
330	Library attendants and assistants
331	Mail carriers, post office
332	Mail handlers, except post office
333	Messengers and office boys
334	Meter readers, utilities
	Office machine operators
341	Bookkeeping and billing machine operators
342	Calculating machine operators
343	Computer and peripheral equipment operators
344	Duplicating machine operators

[1]Category "280 Salesmen and sales clerks, n.e.c." was subdivided in the Census into 5 occupation groups dependent on industry. The industry codes are shown in parentheses.

(continued)

TABLE AI-1 (Continued)

Occupation Code	Clerical and Kindred Workers
281	Sales representatives, manufacturing industries (Ind. 107-399)
282	Sales representatives, wholesale trade (Ind. 017-058, 507-599)
283	Sales clerks, retail trade (Ind. 608-699 except 618, 639, 649, 667, 668, 668)
284	Salesmen, retail trade (Ind. 607, 618, 139, 649, 667, 668, 668)
285	Salesmen of services and construction (Ind. 067-078, 407-499, 707-947)
	Office machine operators - Continued
345	Key punch operators
350	Tabulating machine operators
355	Office machine operators, n.e.c.
360	Payroll and timekeeping clerks
361	Postal clerks
362	Proofreaders
363	Real estate appraisers
364	Receptionists
	Secretaries
370	Secretaries, legal
371	Secretaries, medical
372(Q)	Secretaries, n.e.c.
374	Shipping and receiving clerks
375	Statistical clerks
376	Stenographers
381	Stock clerks and storekeepers
382	Teacher aides, exc. school monitors
383	Telegraph operators
385	Telephone operators
390	Ticket, station, and express agents
391	Typists
392	Weighers
394	Miscellaneous clerical workers
395	Not specified clerical workers

Occupation Code	Craftsmen and Kindred Workers
401	Automobile accessories installers
402	Bakers
403	Blacksmiths
404	Boilermakers

(continued)

TABLE AI-1 (Continued)

Occupation Code	Craftsmen and Kindred Workers
405	Bookbinders
410	Brickmasons and stonemasons
411	Brickmasons and stonemasons, apprentices
412	Bulldozer operators
413	Cabinetmakers
415(R)	Carpenters
416	Carpenter apprentices
420	Carpet installers
421	Cement and concrete finishers
422	Compositors and typesetters
423	Printing trades apprentices, exc. pressmen
424	Cranemen, derrickmen, and hoistmen
425	Decorators and window dressers
426	Dental laboratory technicians
430	Electricians
431	Electrician apprentices
433	Electric power linemen and cablemen
434	Electortypers and sterotypers
435	Engravers, exc. photoengravers
436	Excavating, grading, and road machine operators; exc. bulldozer
440	Floor layers, exc. tile setters
441	Foremen, n.e.c.
442	Forgemen and hammermen
443	Furniture and wood finishers
444	Furriers
445	Glaziers
446	Heat treaters, annealers, and temperers
450	Inspectors, scalers, and graders; log and lumber
452	Inspectors, n.e.c.
453	Jewelers and watchmakers
454	Job and die setters, metal
455	Locomotive engineers
456	Locomotive firemen
461	Machinists
462	Machinist apprentices
	Mechanics and repairmen
470	Air conditioning, heating, and refrigeration
471	Aircraft
472	Automobile body repairmen
473(S)	Automobile mechanics
474	Automobile mechanic apprentices
475	Data processing machine repairmen
480	Farm implement
481	Heavy equipment mechanic, incl. diesel

(continued)

TABLE AI-1 (Continued)

Occupation Code	Craftsmen and Kindred Workers
482	Household appliance accessory installers and mechanics
483	Loom fixers
484	Office machine
485	Radio and television
486	Railroad and car shop
491	Mechanic, exc. auto, apprentices
492	Miscellaneous mechanics and repairmen
495	Not specified mechanics and repairmen
501	Millers; grain, flour, and feed
502	Millwrights
503	Molders, metal
504	Molder apprentices
505	Motion picture projectionists
506	Opticians, and lens grinders and polishers
510	Painters, construction and maintenance
511	Painter apprentices
512	Paperhangers
514	Pattern and model makers, exc. paper
515	Photoengravers and lithographers
516	Piano and organ tuners and repairmen
520	Plasterers
521	Plasterer apprentices
522	Plumbers and pipe fitters
523	Plumber and pipe fitter apprentices
525	Power station operators
530	Pressmen and plate printers, printing
531	Pressman apprentices
533	Rollers and finishers, metal
534	Roofers and slaters
535	Sheetmetal workers and tinsmiths
536	Sheetmetal apprentices
540	Shipfitters
542	Shoe repairmen
543	Sign painters and letters
545	Stationary engineers
546	Stone cutters and stone carvers
550	Structural metal craftsmen
551	Tailors
552	Telephone installers and repairmen
554	Telephone linemen and splicers
560	Tile setters
561	Tool and die makers
562	Tool and die maker apprentices
563	Upholsterers

(continued

TABLE AI-1 (Continued)

Occupation Code	Craftsmen and Kindred Workers
571	Specified craft apprentices, n.e.c.
572	Not specified apprentices
575	Craftsmen and kindred workers, n.e.c.
580	Former members of the Armed Forces

Occupation Code	Operatives, Except Transport
601	Asbestos and insulation workers
602(T)	Assemblers
603	Blasters and powdermen
604	Bottling and canning operatives
605	Chainmen, rodmen and axmen; surveying
610	Checkers, examiners, and inspectors; manufacturing
611	Clothing ironers and pressers
612	Cutting operatives, n.e.c.
613	Dressmakers and seamstresses, except factory
614	Drillers, earth
615	Dry wall installers and lathers
620	Dyers
621	Filers, polishers, sanders, and buffers
622	Furnacemen, smeltermen, and pourers
623	Garage workers and gas station attendants
624	Graders and sorters, manufacturing
625	Produce graders and packers, except factory and farm
626	Heaters, metal
630	Laundry and dry cleaning operatives, n.e.c.
631	Meat cutters and butchers, exc. manufacturing
633	Meat cutters and butchers, manufacturing
634	Meat wrappers, retail trade
635	Metal platers
636	Milliners
640	Mine operatives, n.e.c.
641	Mixing operatives
642	Oilers and greasers, exc. auto
643	Packers and wrappers, except meat and produce
644	Painters, manufactured articles
645	Photographic process workers
	Precision machine operatives
650	Drill press operatives
651	Grinding machine operatives
652	Lathe and milling machine operatives
653	Precision machine operatives, n.e.c.

(continued)

TABLE AI-1 (Continued)

Occupation Code	Operatives, Except Transport
656	Punch and stamping press operatives
660	Riveters and fasteners
661	Sailors and deckhands
662	Sawyers
663	Sewers and stitchers
664	Shoemaking machine operatives
665	Solderers
666	Stationary firemen
	Textile operatives
670	Carding, lapping, and combing operatives
671	Knitters, loopers, and toppers
672	Spinners, twisters, and winders
673	Weavers
674	Textile operatives, n.e.c.
680	Welders and flame-cutters
681	Winding operatives, n.e.c.
690	Machine operatives, miscellaneous specified
692	Machine operatives, not specified
694	Miscellaneous operatives
695	Not specified operatives
701	Boatmen and canalmen
703	Bus drivesr
704	Conductors and motormen, urban rail transit
705	Deliverymen and routemen
706	Fork lift and tow motor operatives
710	Motormen; mine, factory, logging camp, etc.
711	Parking attendants
712	Railroad brakemen
713	Railroad switchmen
714	Taxicab drivers and chauffeurs
715(U)	Truck drivers

Occupation Code	Laborers, Except Farm
740	Animal caretakers, exc. farm
750	Carpenters' helpers
751(V)	Construction laborers, exc. carpenters' helpers
752	Fishermen and oystermen
753	Freight and material handlers
754	Garbage collectors
755	Gardeners and groundskeepers, exc. farm
760	Longshoremen and stevedores
761	Lumbermen, raftsmen, and woodchoppers

(continued)

TABLE AI-1 (Continued)

Occupation Code	Laborers, Except Farm
762	Stock handlers
763	Teamsters
764	Vehicle washers and equipment cleaners
770	Warehousemen, n.e.c.
780	Miscellaneous laborers
785	Not specified laborers

Occupation Code	Farmers and Farm Managers
801(W)	Farmers (owners and tenants)
802	Farm managers
821	Farm foremen
822	Farm laborers, wage workers
823	Farm laborers, unpaid family workers
824	Farm service laborers, self-employed

Occupation Code	Service Workers, Exc. Private Household
	Cleaning service workers
901	Chambermaids and maids, except private household
902	Cleaners and charwomen
903(X)	Janitors and sextons
	Food service workers
910	Bartenders
911	Busboys
912	Cooks, except private household
913	Dishwashers
914	Food counter and fountain workers
915(Y)	Waiters
916	Food service workers, n.e.c., except private household
	Health service workers
921	Dental assistants
922	Health aides, exc. nursing
923	Health trainees
924	Lay midwives
925	Nursing aides, orderlies, and attendants
926	Practical nurses
	Personal service workers
931	Airline stewardesses
932	Attendants, recreation and amusement

(continued)

TABLE AI-1 (Continued)

Occupation Code	Service Workers, Exc. Private Household
933	Attendants, personal service, n.e.c.
934	Baggage porters and bellhops
935	Barbers
940	Boarding and lodging housekeepers
941	Bootblacks
942	Child care workers, exc. private household
943	Elevator operators
944	Hairdressers and cosmetologists
945	Personal service apprentices
950	Housekeepers, exc. private household
952	School monitors
953	Ushers, recreation and amusement
954	Welfare service aids
	Protective service workers
960	Crossing guards and bridge tenders
961	Firemen, fire protection
962	Guards and watchmen
963	Marshals and constables
964	Policemen and detectives
965	Sheriffs and bailiffs

Occupation Code	Private Household Workers
980	Child care
981	Cooks, private household
982	Housekeepers, private household
983	Laundresses, private household
984(Z)	Maids and servants, private household

995	Occupation Not Reported[2]

[2]This code is used to identify not reported occupation in surveys where the not reported cases are not allocated.

TABLE AI-1 (Continued)

Occupation Code	Allocation Categories[3]
196	Professional, technical, and kindred workers - allocated
246	Managers and administrators, except farm - allocated
296	Sales workers - allocated
396	Clerical and kindred workers - allocated
586	Craftsmen and kindred workers - allocated
696	Operatives, except transport - allocated
726	Transport equipment operatives - allocated
796	Laborers, except farm - allocated
806	Farmers and farm managers - allocated
846	Farm laborers and farm foremen - allocated
976	Service workers, exc. private household - allocated
986	Private household workers - allocated

[3]Those returns from the Population Census which do not have an occupation entry are allocated among the major occupation groups during computer processing. These cases are labeled with the code for the "allocation" category to which they are assigned.

TABLE AI-2

Projected Wage and Salary Employment by Industry 1975 and 1981 by SIC Code

Missouri

SIC Code	Industry	Projected Employment 1975	Projected Employment 1981
01,07-09	Agric., Forestry & Fish.	143,717	116,067
10-14	Mining	10,185	10,902
15-17	Construction	94,056	87,090
19-39	Manufacturing	455,181	480,901
19	Ordnance	5,582	2,978
20	Food & Kindred	47,915	46,354
22	Textile Mill Products	1,982	1,930
23	Apparel & Other Textiles	31,998	39,198
24	Lumber & Wood exc. furniture	9,602	12,714
25	Furniture & Fixtures	8,710	11,736
26	Paper & Allied	13,171	13,642
27	Printing & Publishing	33,066	34,451
28	Chemicals & Allied	26,655	26,972
29	Petroleum & Coal Products	868	1,000
30	Rubber & Misc. Plastic	11,038	14,173
31	Leather & Leather Products	31,005	32,203
32	Stone, Clay & Glass	13,256	13,709
33	Primary Metal	15,911	19,293
34	Fabricated Metal	30,382	30,546
35	Machinery exc. Electrical	35,426	39,122
36	Elect. Mach., Equip., Sup.	50,356	51,001
37	Transportation Equip.	71,111	69,714
38	Instruments & Related	7,669	8,425

TABLE AI-2 (Continued)

SIC Code	Industry	Projected Employment 1975	Projected Employment 1981
39	Misc. Mfg.	9,475	11,740
40-49	Trans., Comm. Util.	146,195	144,800
50,52-59	Wholesale & Retail Trade	482,581	547,125
60-67	Finance, Ins. & Real Estate	98,702	117,719
70-89	Services	336,913	393,944
91	Federal Government	57,488	54,015
92-93	State & Local Government	296,973	350,121
Total	Total Employment	2,121,991	2,305,684

Source: MOTIS Employment Projections 1975-1981

TABLE AI-3

Projected Employment by
Vocational Program Area
1975

		Projected Employment
01.00	Agriculture	157,285
04.00	Distributive	219,372
07.00	Health	54,476
09.00	Home Economics	18,841
14.00	Office Occupations	358,335
16.00	Technology	11,627
17.00	Trade and Industry	641,962
	Total	1,461,898

Source: MOTIS Employment Projections
1975-1981

TABLE AI-4

Conversion of Census Occupations to Dictionary of Occupational Titles

CES	DOT
003	020.168
004	012.168
005	020.188
024	490.168
025	162.158
080	078.281
081	078.368
082	079.368
083	078.368
084	079.368
085	079.368
150	049.384
151	029.281
152	010.281
153	003.181
155	007.181
163	196.682
164	193.168
165	338.381
170	621.281
172	007.187
173	002.281
202	186.168
203	162.158
205	162.158
210	168.168
211	187.168
215	168.168
226	910.138
230	187.168
231	162.158
233	163.118
341	215.488
342	215.488
343	213.382
244	207.782
345	213.582
250	213.782
355	207.782
360	215.488
361	232.368
362	209.368
363	191.387
370	201.368

(continued)

TABLE AI-4 (Continued)

CES	DOT
371	201.368
372	201.368
375	219.388
376	202.388
391	203.588
394	249.
401	806.884
402	526.781
404	805.281
405	653.782
410	861.781
411	861.781
413	660.380
415	860.381
416	680.381
420	299.381
421	844.781
422	973.381
423	851.782
425	298.381
430	824.281
431	824.281
435	704.884
436	850.883
440	864.781
441	559.138
442	611.782
443	667.782
444	785.261
445	865.781
450	764.687
461	600.280
462	600.280
470	637.281
471	621.281
472	807.381
473	620.281
474	620.281
475	003.181
481	620.281
482	827.281
483	683.280
484	633.281
485	720.281
491	807.381
492	620.281

(continued)

TABLE AI-4 (Continued)

CES	DOT
501	521.138
502	638.281
503	518.381
504	518.381
515	971.281
522	862.381
523	862.381
525	952.782
530	651.782
533	651.782
535	617.782
536	804.281
542	804.281
543	365.381
545	950.782
546	861.781
550	801.781
551	785.261
552	822.381
554	822.381
560	861.781
561	601.280
562	601.280
563	780.884
601	863.884
603	859.281
612	168.287
611	363.884
613	785.361
620	580.885
622	512.782
623	915.867
635	500.380
636	784.281
645	976.381
650	606.380
651	603.280
652	604.885
656	615.782
660	800.782
662	660.280
664	690.782
665	502.782
666	951.885
670	580.885
671	685.885

(continued)

TABLE AI-4 (Continued)

CES	DOT
672	682.885
673	683.782
674	787.885
680	816.782
681	616.885
690	600.380
694	604.380
703	913.463
704	910.138
705	922.137
706	929.887
710	913.463
714	913.463
715	913.463
740	356.874
750	869.887
753	929.887
755	407.884
760	929.887
761	449.287
762	406.884
763	913.463
801	421.181
802	180.168
821	429.131
822	421.883
823	421.883
824	421.883
901	323.887
902	381.887
903	382.887
911	311.878
914	311.878
915	311.878
916	311.878
921	079.378
922	079.128
924	354.878
925	355.878
931	352.878
932	341.368
935	324.878
940	330.371
942	320.137
944	359.878
952	332.271

(continued)

TABLE AI-4 (Continued)

CES	DOT
953	359.878
954	079.128
962	377.868
963	377.868
964	375.268
965	377.868
980	359.878
983	302.887
984	323.887
213	168.168
162	029.381
216	186.168
245	187.168
265	191.268
315	184.168
325	219.388
326	191.268
330	239.368
331	231.388
332	231.388
374	222.388
383	230.878
384	239.368
390	184.168
511	840.781
480	620.281
486	700.884
510	840.781
512	840.781
514	700.884
534	866.381
615	842.781
630	363.887
663	785.381
701	376.868
752	441.384
926	079.378
982	303.138
950	303.138
961	373.168
454	514.380
374	222.387
314	249.368
260	258.358
261	294.258

(continued)

TABLE AI-4 (Continued)

CES	DOT
271	251.258
280	263.358
264	200.358
262	200.358
225	162.158

TABLE AI-5

Reallocation of Census Occupations through Discriminant Analysis

Vocational		Untrained		Professional	
CES	Occupation	CES	Occupation	CES	Occupation
081	Dental Hygienists	260	Advertising Agents and Salesmen	003	Computer Programmers
082	Health record tech. and technicians	261	Auctioneers	004	Computer Systems Analyst
083	Radiologic Technologists and technicians	262	Demonstrators	005	Computer Specialists, n.e.c.
084	Therapy Assistants	264	Hucksters and Peddlers	024	Farm Management advisors
150	Agricultural and biological tech. except health	325	File Clerk	025	Foresters & Conservationists
152	Draftsmen	383	Telegraph Messengers	080	Clinical Laboratory tech. and technologist
153	Electrical and Electronic engineering technicians	401	Automobile Accessories Installers	151	Chemical Technicians
155	Mechanical Engineering tech.	411	Brickmasons and Stonemasons, apprentices	162	Engineering and Science Technicians n.e.c.
163	Airplane Pilots	425	Decorators and Window dressers	172	Tool Programmers, Numerical Control
164	Airtraffic Controllers	436	Excavating, grading, and road machine operators, Bulldozers	202	Bank Officers and Financial Managers
165	Embalmers	450	Inspectors, scalers and graders; log and lumber inspectors, n.e.c.	203	Buyers and Supplies Farm Products
170	Flight Engineers	486	Railroad and Car Shop Repairmen	205	Buyers, Wholesale and Retail Trade
173	Technicians, n.e.c.	514	Pattern and Mold Makers except paper	210	Credit Men
226	Railroad Conductors	563	Upholsterers	211	Funeral Directors
280	Salesmen and Sales Clerks, n.e.c.	601	Asbestos & insulation workers	213	Construction Administers, Public Administration
301	Bank Tellers	611	Clothing Ironers & Pressers		
303	Billing Clerks	620	Dyers		
305	Bookkeepers	623	Garage Workers and Gas Station Attendants		
310	Cashiers	630	Laundry & dry cleaning operatives, n.e.c.		

(continued)

TABLE AI-5 (Continued)

Vocational		Untrained		Professional	
CES	Occupation	CES	Occupation	CES	Occupation
311	Clerical Assistants, Social Welfare	652	Lathe and Millire Machine Operators	215	Inspectors, except construction, Public Administration
314	Counter Clerks, except food	666	Stationary Firemen	216	Managers and Superintendents in Buildings
315	Dispatchers and Starter Vehicle	670	Carding, Lapping and combinions operators	225	Purchasing Agents and Buyers, n.e.c.
330	Library Attendants and Assis.	671	Knitters, loopers and toppers	230	Restaurant, Cafeteria and Bar Managers
331	Mail Carriers, Post Office	672	Spinners, twister, winders	231	Sales Managers and Department Heads, Retail Trade
332	Mail Handlers, except Post Office	676	Textile operators, n.e.c.	233	Sales Managers, except Retail Trade
341	Bookkeeping and Billing Machine Operators	681	Winding operatives, n.e.c.	245	Managers and Administrators, n.e.c.
342	Calculative Machine Operators	701	Boatmen and Canalmen	265	Insurance Brokers, agents, and underwriters
343	Computer and Perpheral Equip. Operators	706	Fork lift and tow motor operators	270	Real Estate agents and Brokers
344	Duplicating Machine Operators	740	Animal Caretakers except Farm	271	Stock and Bond Salesmen
345	Key Punch Operators	750	Carpenters helpers	313	Collectors, Bill and Account
350	Tabulating Machine Operators	753	Freight and Materials Handlers	326	Insurance Adjusters, Examiners and Investigators
355	Office Machine Operators, n.e.c.	755	Gardeners and Grounds keepers except Farm	363	Real Estate Appraisers
360	Payroll and Timekeeper clerks	760	Longshoremen & stevedores		
361	Postal Clerks	761	Lumbermen, raftsmen and woodchoppers		
362	Proofreaders	762	Stock Handlers		
370	Secretaries, Legal	822	Farm Laborers, wage workers		
371	Secretaries, Medical	823	Farm Laborers, unpaid family workers		
372	Secretaries, n.e.c.	824	Farm service laborers self-employed		
374	Shipping and Receiving Clerks	901	Chambermaids & maids ext., household		
375	Statistical Clerks				
376	Stenographers				
384	Telegraph operators				

(continued)

TABLE AI-5 (Continued)

Vocational		Untrained		Professional	
CES	Occupation	CES	Occupation	CES	Occupation
390	Ticket, Station, and Express Agents	902	Cleaners & Charwomen	610	Checkers, examiners, and inspectors manufacturing
391	Typists	903	Janitors & Sexton	802	Farm Managers
394	Miscellaneous Clerical Workers	911	Busboys	961	Firemen, Fire Protection
402	Bakers	914	Food counter & Fountain workers	964	Policemen and detectives
404	Boilermakers	915	Waiters		
405	Bookbinders	916	Food Service Workers n.e.c. etc., private household		
410	Brickmasons and Stonemasons	924	Lay midwives		
413	Cabinetmakers	925	Nursing aides, orderlies and attendants		
415	Carpenters	931	Airline Stewardesses		
416	Carpenter Apprentices	932	Attendants recreation and amusement		
420	Carpet Installers	934	Baggage Porters & Bellhops		
421	Cement and Concrete Finishers	942	Child Care Workers except private household		
422	Compositors and Typesetters	950	Housekeepers, exc., private household		
423	Printing trades apprentices except pressmen	952	School visitors		
430	Electrician	953	Ushers, recreational and amusement		
431	Electrician Apprentices	962	Guards and Watchmen		
433	Electric Power Linesmen and cablemen	963	Marshals and Constables		
435	Engravers, exc. Photoengravers	965	Sheriffs and Baliffs		
441	Foremen, n.e.c.	980	Child care workers private household		
442	Forgemen and hammermen	983	Launders, Private household		
443	Furniture and Wood Finishers				
444	Furriers				
445	Glaziers				
454	Job and die setters, metal				

(continued)

TABLE AI-5 (Continued)

Vocational		Untrained		Professional	
CS	Occupation	CES	Occupation	CES	Occupation
461	Machinists	984	Maids and Servants, Private households		
462	Machinist Apprentices				
470	Airconditioning, Heating, and Refrigeration Mechanic				
471	Aircraft Mechanic				
473	Automobile Mechanics				
474	Automobile Mechanic Apprentices				
475	Data Processing Machine Repairmen				
480	Farm Implement Mechanic				
481	Heavy Equipment Mechanic, incl. diesel				
482	Household appliance and accessory installers & mechanics				
483	Loom Fixers				
484	Office Machine Repairmen				
485	Radio & Television Repairmen				
491	Mechanic, except auto apprentices				
492	Miscellaneous Mechanics and Repairmen				
501	Millers, grain, flour, feed				
502	Millwrights				
503	Moulders, Metal				
504	Moulders, Apprentices				
510	Painters, Construction and Maintenance				
511	Painter Apprentices				
512	Paper hangers				

(continued)

TABLE AI-5 (Continued)

Vocational		Untrained		Professional	
CES	Occupation	CES	Occupation	CES	Occupation
515	Photoengravers and lithographers				
522	Plumbers & Pipefitters				
523	Plumbers & Pipefitters Apprentices				
525	Power Station Operators				
530	Pressmen and Plate Printers, Printing				
531	Pressmen Apprentices				
533	Rollers and Finishers, Metal				
534	Roofers and Slaters				
535	Sheetmetal workers & tinsmiths				
536	Sheetmetal Apprentices				
542	Shoe Repairmen				
543	Sign Painters & Letterers				
545	Stationary Engineers				
546	Stone cutters and Stone Carvers				
550	Structural Metal Craftsmen				
551	Tailors				
552	Telephone installers & repairmen				
554	Telephone linemen and splicers				
560	Tile setters				
561	Tool and die makers				
562	Tool and die maker apprentices				
603	Blasters & Powder men				
613	Dressmakers and Seamstresses, except factory				

(continued)

TABLE AI-5 (Continued)

Vocational		Untrained		Professional	
CES	Occupation	CES	Occupation	CES	Occupation
622	Furnacemen, Smelters, & Pourers				
635	Metal Platers				
636	Milliners				
645	Photographic Process Workers				
650	Drill Press Operators				
651	Grinding Machine Operators				
656	Punch and Stamping Press				
660	Riveters and Fasteners				
662	Sawers				
663	Sewers and Stitchers				
664	Shoemaking Machine Operators				
665	Solderers				
673	Weavers				
680	Welders and Flame Cutters				
690	Machine Operatives, Misc. specified				
694	Miscellaneous Operatives				
703	Bus Drivers				
704	Conductors and Motormen Urban Rail Transit				
705	Delivermen and Routemen				
710	Motormen, Mine, Factory, logging camp				
714	Taxi Drivers & Chauffeurs				
715	Truck Drivers				
752	Fishermen and Oystermen				

(continued)

TABLE AI-5 (Continued)

Vocational		Untrained		Professional	
CES	Occupation	CES	Occupation	CES	Occupation
763	Teamsters				
801	Farmers (owners & tenants)				
821	Farm Foremen				
921	Dental Assistant				
922	Health Aides, except Nursing				
926	Practical Nurses				
935	Barbers				
940	Boarding and lodging housekeepers				
944	Hairdressers and cosmetologists				
954	Welfare Service Aides				

TABLE AI-6

Cost of a Completer

Program	OE Code	Average Cost/ ENR	Length of Program	Cost/ Completion (Cij)
Prod. Ag.	01.01	1631	4	6524
Ag S/S	1.02	1045	4	4180
Ag Mech.	1.03	1280	4	5120
Ag Production	1.04	1250	4	5000
Ornamental Hort.	1.05	1207	4	4828
Agriculture Resources	1.06	1250	4	5000
Ag. Res./Forestry	1.07	1094	4	4376
Agriculture - Others	1.99	1250	4	5000
APV Services	4.01	1053	2	2106
Appliances	4.02	1254	2	2508
Automotive	4.03	1171	2	2342
Fin. Credit	4.04	959	2	1918
Floristry	4.05	1118	2	2236
Food Dist.	4.06	1285	2	2570
Food Service	4.07	1436	2	2872
Gar Merch	4.08	1102	2	2204
H/BM/FG	4.09	1026	2	2052
Home Furn.	4.10	1124	2	2248
Hotel Lodg.	4.11	2946	2	5892
Ind. Mnf.	4.12	1923	2	3846
Ins.	4.13	556	2	1112
Per Ser	4.15	1088	2	2176
Petroleum	4.16	1426	2	2852
Real Estate	4.17	826	2	1724
Rec. Tourism	4.18	1152	2	2304

(continued)

TABLE AI-6 (Continued)

Program	OE Code	Average Cost/ ENR	Length of Program	Cost/ Completion (Cij)
Transportation	4.19	1181	2	2362
Misc. Distr.	4.99	693	2	1386
Dent Assis.	7.0101	915	2	1830
Dent Hyg.	7.0102	2175	2	4350
Med Lab Assis.	7.0203	1401	2	2802
Prac. Nurs.	7.0302	927	2	1854
Nurse Aide	7.0303	907	2	1814
Surg Tech	7.0305	1475	2	2950
Phy Therp.	7.0402	1244	2	2488
Rad Tech.	7.0501	2175	2	4350
Inhl. Therp.	7.0903	1065	2	2130
Med. Assis.	7.0904	1326	2	2652
Mort Sci	7.0909	681	2	1962
Health - Other	7.99	907	2	1814
Child Care	9.0301	1150	2	2300
Cl Mgt PS	9.0202	1435	2	2870
Fd. Mgt.	9.0203	1288	2	2576
Ins. H-M-S	9.0205	1337	2	2674
Acnt. Comp.	14.01	1515	2	3030
Bus. D-P	14.02	1426	2	2852
Fil - Off Mch.	14.03	1324	2	2648
M/Post - Ck	14.0403	1050	1	2100
Mess/OB/OG	14.0405	1050	2	2100
Inf/Com/other	14.0499	1050	2	2100
Shp. Rec. Clk	14.0503	1296	2	2592
Steno-Sec.	14.0700	1223	2	2446
Sp/Adm/other	14.0899	1299	2	2598

(continued)

TABLE AI-6 (Continued)

Program	OE Code	Average Cost/ ENR	Length of Program	Cost/ Completion (Cij)
Typing - rel.	14.0900	1223	2	2446
Office/other	14.99	1000	2	2000
Aeronautic Tech.	16.0101	903	2	1806
Arch. Tech.	16.0103	884	2	1768
Civil Tech.	16.0105	1677	2	3354
Chem Tech.	16.0106	902	2	1804
Electric Tech.	16.0107	1450	2	2900
Electron Tech	16.0108	1450	2	2900
Electro-Mech	16.0109	1450	2	2900
Env. Contr.	16.0110	3018	2	6036
Mech. Tech.	16.0113	1450	2	2900
Comm. Pilot	16.0601	1749	2	3498
Misc. Tech.	16.0699	1749	2	3498
Air Cond.	17.01	1155	2	2310
Elect. Appl.	17.0201	1336	2	2672
Gas App.	17.0202	1336	2	2672
Auto Body	17.0301	1110	2	2220
Auto Mech.	17.0302	1110	2	2220
Spec. Other	17.0303	1100	2	2220
Airc. Maint.	17.0401	1350	2	2700
Air. Operator	17.0402	1375	2	2750
Ground Operator	17.0403	1200	2	2400
Bus Ma. Rep.	17.0600	1549	2	3098
Comm. Ant.	17.0700	1142	2	2284
Comm. Photo	17.09	796	2	1592
Carpentry	17.1001	1150	2	2300

(continued)

TABLE AI-6 (Continued)

Program	OE Code	Average Cost/ ENR	Length of Program	Cost/ Completion (Cij)
Electricity	17.1002	1215	2	2430
Livg. Eq. Op.	17.1003	1308	2	2612
Masonry	17.1004	1523	2	3046
Paint/Dec.	17.1005	1175	2	2350
Plastering	17.1006	1523	2	3046
Plumb/Pipe	17.1007	992	2	1984
Dry Wall	17.1008	1216	2	2432
Roofing	17.1010	1216	2	2432
Other Cons.	17.1099	1216	2	2432
Cost Serv.	17.1100	1317	2	2634
Drafting	17.13	1272	2	2544
Elect. Occ.	17.14	964	2	1928
Electron Occ.	17.15	1125	2	2250
Laundry/Occ.	17.16	1025	2	2050
Foreman/Sup.	17.17	1924	2	3848
Graph Arts	17.19	1418	2	2836
Metal Work	17.23	1336	2	2672
Barbering	17.2601	1110	2	2220
Cosmetology	17.2602	1110	2	2220
Fireman Tr.	17.2801	876	2	1752
Law Enf.	17.2802	1580	2	3160
Pub. Ser. Other	17.2899	1224	2	2448
Quant. Food	17.29	892	2	1784
Refrig.	17.30	961	2	1922
Sml. Eng. Rep.	17.31	1217	2	2434
Stat. En. SC	17.32	1209	2	2418
Textile Pr.	17.33	1142	2	2284

(continued)

TABLE AI-6 (Continued)

Program	OE Code	Average Cost/ ENR	Length of Program	Cost/ Completion (Cij)
Leather Worker	17.34	1004	2	2008
Upholster	17.35	1004	2	2008
Wood Work	17.36	1141	2	2282
Trd./Ind./Other	17.99	1150	2	2300

TABLE AI-7

Average Cost and Expenditures for Vocational Programs in Missouri

Program	OE Code	Avg Cost/ENR	ENR	Expenditures
Production Agric.	01.01	1631	11862	$19,346,922
Agric. Supplies Service	01.02	1045	561	586,245
Agric. Mechanics	01.03	1280	5005	6,406,400
Agric. Products	01.04	1250	220	275,000
Ornamental Horticulture	01.05	1207	391	471,937
Agric. Resources	01.06	1250	87	108,750
Forestry	01.07	1094	153	167,382
Agric. Other	01.99	1250	316	395,000
Advertising Services	04.01	1053	150	157,950
Apparel & Accessories	04.02	1254	756	948,024
Automotive	04.03	1171	352	412,192
Finance & Credit	04.04	959	174	166,866
Floristry	04.05	1118	83	92,794
Food Distribution	04.06	1285	767	985,595
Food Service	04.07	1436	1235	1,773,460
Merchandise	04.08	1102	2271	2,502,642
Hardware, Farm & Garden, & Equip.	04.09	1026	286	293,436
Home Furnishings	04.10	1124	79	88,796
Hotel & Lodging	04.11	2946	67	197,382
Industrial Marketing	04.12	1923	70	134,610
Insurance	04.13	556	17	9,452
International Trade	04.14	1416	13	8,408
Personal Services	04.15	1088	240	261,120
Petroleum	04.16	1426	202	288,052
Real Estates	04.17	862	683	588,746
Recreation, Tourism/Other	04.18	1152	131	150,912

(continued)

TABLE AI-7 (Continued)

Program	OE Code	Avg Cost/ENR	ENR	Expenditures
Transportation	04.19	1181	83	98,023
Retail Trade, Other	04.20	1503	645	969,435
Retail Trade, Other	04.21	1503	105	157,815
Misc. Distribution	04.99	693	279	193,347
Dental Assistant	07.0101	915	66	60,390
Dental Hygenists	07.0102	2175	1	2,175
Dental Lab Tech.	07.0103	1123	11	12,353
Med. Lab Assisting	07.0203	1401	13	18,213
Med. Lab/Other	07.0210	1243	4	4,972
Med. Lab/Other	07.0299	1243	3	3,729
Nursing (Assoc. Degree)	07.0301	927	22	20,394
Practical (Voc.) Nursing	07.0302	733	56	41,048
Nursing Assistant (Aide)	07.0303	907	531	481,617
Surgical Tech. OR Tech.	07.0305	1475	1	1,475
Home Health Aide	07.0307	1549	3	4,641
Nursing/Other	07.0399	1317	16	21,072
Occup. Therapy	07.0401	1155	7	8,085
Physical Therapy	07.0402	1244	12	14,982
Radiologic Technician	07.0501	2175	8	17,400
Inhalation Therapy	07.0903	1065	6	6,390
Med. Assis. (in Physician's Office)	07.0904	1326	10	13,260
Community Health Aid	07.0906	1549	326	504,974
Medical Emergency Tech.	07.0907	937	5	4,685
Mortuary Science	07.0909	681	1	681
Health Occup.	07.9901	907	19	17,233
Child Care Services	90.0201	1150	559	642,850
Clothing Services	09.0202	1434	332	476,088
Food Mgmt. Pdct. & Ser.	09.0203	1288	778	1,002,064
Home Furn., Equip. & Ser.	09.0204	1125	132	148,500

(continued)

TABLE AI-7 (Continued)

Program	OE Code	Avg Cost/ENR	ENR	Expenditures
Institutional Mgmt. Services	09.0205	1337	31	41,447
Occupational Prep. Other	09.0299	992	107	106,144
Accounting & Computing	14.01	1515	2848	4,314,720
Bus. Data Proc. System Occup.	14.02	1426	1255	1,789,630
Filing, Office Mach. & General	14.03	1324	2456	3,398,703
Info. Communication Occup.	14.04	1050	114	119,700
Material Support Sys.	14.05	1296	24	31,104
Personnel Training & Rel. Occup.	14.06	764	42	32,088
Steno., Secretaries, & Related	14.07	1223	3884	4,750,132
Supervisory & Admn. Mgmt. Occup.	14.08	1299	37	48,063
Office Occup./Other	14.99	1000	4889	4,889,000
Engineering-Related Tech.	16.01	1677	3	5,031
Aeronautical Tech.	16.0101	903	1	903
Architectural Tech. (Bldg. Const)	16.0103	884	21	18,564
Automotive Techn.	16.0104	1171	106	124,126
Chemical Techn.	16.0105	902	1	902
Civil Techn.	16.0106	1677	3	5,031
Chemical Techn.	16.0107	902	24	21,648
Chemical Techn.	16.0108	902	154	138,908
Electrical/Electronic Electro-Mechanic Tech.	16.0109	1450	2	2,900
Environmental-Control Tech.	16.0110	3018	3	9,054
Industrial Tech.	16.0111	1677	0	- -
Instrumentation Tech.	16.0112	3605	0	- -
Mechanical Tech.	16.0113	1450	30	43,500
Scientific Data Processing	16.0117	1135	364	413,140
Technological Educ. Other	16.0198	1749	146	255,354
Computer Programmer	16.0401	1135	38	43,130

(continued)

TABLE AI-7 (Continued)

Program	OE Code	Avg Cost/ENR	ENR	Expenditures
Fire & Fire Safety Tech.	16.0602	877	0	- -
Police Sc. Tech. Law Enforcement & Corrections	16.0605	1116	1	1,116
Air Conditioning	17.01	1155	388	448,140
Heating	17.0102	1155	22	25,410
Appliance Repair	17.0200	1336	138	138,368
Auto Body	17.0301	1110	1311	1,455,210
Auto Mechanics	17.0302	1110	3051	3,386,610
Blueprint Reading	17.0500	549	2	1,098
Bus. Machine Maint.	17.06	1549	103	159,547
Commercial Art Occup.	17.07	1142	269	307,198
Commercial Photo	17.09	796	27	21,492
Carpentry	17.1001	1150	2547	3,929,050
Electricity	17.1002	1215	318	386,370
Heavy Equipment	17.1003	1308	16	20,928
Masonry	17.1004	1523	116	176,668
Plumbing & Pipefitting	17.1007	992	119	118,048
Construction & Maint. Trade Other	17.1099	1216	157	190,912
Custodial Services	17.11	1317	251	330,567
Diesel Mechanic	17.12	1266	149	188,634
Drafting	17.13	1272	592	753,024
Electronic Occup.	17.14	664	157	104,248
Electrical Occup.	17.15	1201	1125	1,351,125
Foremanship, Sup. Mgmt. Devel.	17.17	1924	63	121,212
Graphic AAB Occup.	17.19	1418	1072	1,520,096
Instr. Maint. & Repair	17.21	1336	26	34,736
Maritime Occup.	17.22	993	2	1,986
Metal Working	17.23	1336	2395	3,199,720
Metallurgy	17.24	1597	10	15,970

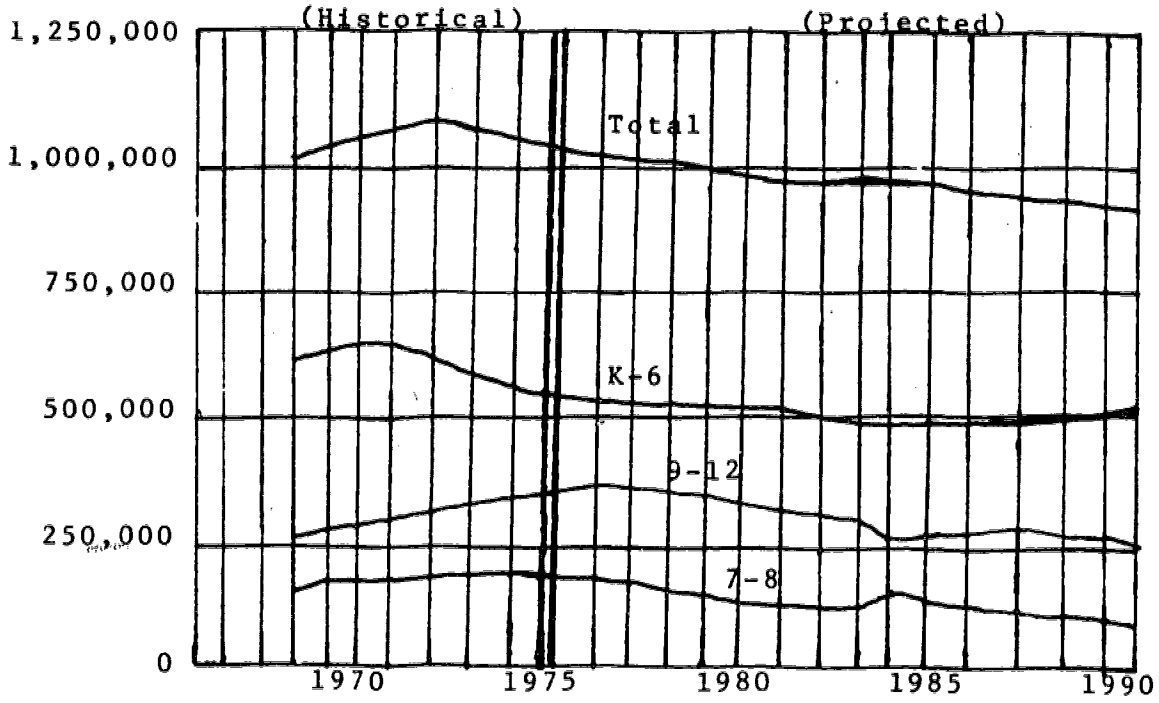
(continued)

TABLE AI-7 (Continued)

Program	OE Code	Avg Cost/ENR	ENR	Expenditures
Cosmetology	17.2602	1110	207	229,770
Plastics Occup.	17.27	1540	5	7,700
Fireman Training	17.2801	876	2	1,752
Law Enforcement	17.2802	1580	28	44,240
Public Ser. Occup., Other	17.2899	1224	115	140,760
Quantity Food Occup.	17.29	892	525	468,300
Refrigeration	17.30	961	366	351,726
Small Engine & Repair Internal Combustion	17.31	1217	641	780,097
Stationary Food Occup.	17.32	1209	1	1,209
Textile Product Fab.	17.33	1142	95	108,490
Leatherworking	17.34	1004	5	5,020
Woodworking	17.36	1141	160	180,560
Total Expenditures			63,476	$75,727,550

TABLE AI-8

ENROLLMENT BY GRADE 1968-1990



HISTORICAL

YEAR	K-6	7-8	9-12	Total
1968	602920	154143	278991	1031010
1969	616895	161477	283274	1060646
1970	628383	165171	284893	1078447
1971	620318	169647	294868	1084833
1972	608451	172548	306986	1087985
1973	592562	175714	314468	1082744
1974	571372	177137	321431	1069940
1975	552729	175061	326083	1053879

PROJECTED

1976	541007	172429	331472	1044908
1978	528347	161294	331017	1021257
1981	512614	137101	303156	952872
1984	493829	147978	268824	910631
1987	498419	134551	279382	909352
1990	518381	132888	255360	906630

TABLE AI-9

Entry Level Wages by Instruction Programs

Instructional Program	O.E. Program Code	Entry Level Wages
Production Agriculture	1.0100	$7,100
Agriculture Supplies/Services	1.0200	6,831
Agriculture Mechanics	1.0300	5,945
Agriculture Products	1.0400	6,597
Ornamental Horticultures	1.0500	5,746
Agriculture Resources	1.0600	6,225
Agrilcuture Resources Forestry	1.0700	6,225
Agriculture, Other	1.9900	6,225
Advertising Services	4.0100	6,560
Apparel and Accessories	4.0200	5,320
Automotive	4.0300	7,410
Finance and Credit	4.0400	5,600
Floristry	4.0500	3,040
Food Distribution	4.0600	3,591
Food Service	4.0700	3,040
General Merchandise	4.0800	4,800
Hardware, Bldg. Mat., Farm & Garden Supplies & Equipment	4.0900	4,800
Home Furnishings	4.1000	4,800
Hotel & Lodging	4.1100	3,200
Industrial Marketing	4.1200	9,000
Insurance	4.1300	8,000
Personal Services	4.1500	4,000
Petroleum	4.1600	3,800
Real Estate	4.1700	8,000
Recreation & Tourism, Other	4.1800	4,800
Transportation	4.1900	8,778
Miscellaneous Distribution	4.9900	5,300
Dental Assistant	7.0101	6,200
Dental Hygienists	7.0102	7,800
Medical Lab. Assisting	7.0203	6,200
Practical Nursing	7.0302	6,505
Nursing Aide	7.0303	4,850
Surgical Technician	7.0305	6,700
Physical Therapy Assistant	7.0402	6,882
Radiologic Technician	7.0501	6,800
Inhalation Therapist	7.0903	6,400
Medical Assistant	7.0904	6,100
Mortuary Science	7.0909	7,500
Health, Other	7.9900	6,300
Child Care Services	9.0201	2,500
Clothing Services	9.0202	5,400
Food Mgmt Production & Services	9.0203	4,800

(continued)

TABLE AI-9 (Continued)

Instructional Program	O.E. Program Code	Entry Level Wages
Institutional Mgmt. Services	9.0205	5,100
Accounting & Computing	14.0100	5,600
Business Data Processing Sys. Occup.	14.0200	6,350
Filing, Office Mach. & Gen. Office Clerical Help	14.0300	4,800
Mail & Postal Clerks	14.0403	5,000
Messengers & Office Boys & Girls	14.0405	3,040
Info. Communication Occup. Other	14.0499	5,000
Shipiing & Receiving Clerk	14.0503	6,650
Steno, Secretarial & Related Office	14.0700	6,180
Supervisory & Admin. Mgmt. Occup.	14.0899	5,200
Typing - Related	14.0900	4,500
Office, Other	14.9900	5,400
Aeronautical Technology	16.0101	7,300
Architectual Technology	16.0103	7,100
Civil Technology	16.0105	7,600
Chemical Technology	16.0106	7,500
Electrical Technology	16.0107	8,000
Electronic Technology	16.0108	8,000
Electro-mechanical Technology	16.0109	7,100
Environmental Technology	16.0110	6,800
Mechanical Technology	16.0113	7,300
Commercial Pilot Training	16.0601	16,000
Misc. Technical Education, Other	16.0699	7,400
Air Conditioning	17.0100	7,600
Electrical Appliance	17.0201	6,175
Gas Appliance	17.0202	7,600
Auto Body	17.0301	8,600
Auto Mechanic	17.0302	9,000
Specialization, Other	17.0303	7,200
Aircraft Maintenance	17.0401	7,961
Aircraft Operations	17.0402	7,800
Ground Operations	17.0403	8,000
Business Machine Maintenance	17.0600	7,900
Commercial Art	17.0700	5,300
Commercial Photography	17.0900	4,300
Carpentry	17.1001	7,040
Electricity	17.1002	7,780
Heavy Equipment Operator	17.1003	7,300
Masonry	17.1004	7,500
Painting & Decorating	17.1005	6,707
Plastering	17.1006	5,000
Plumbing & Pipefitting	17.1007	8,900
Dry Wall Installation	17.1008	5,000

(continued)

TABLE AI-9 (Continued)

Instructional Program	O.E. Program Code	Entry Level Wages
Roofing	17.1010	7,000
Other Construction & Maintenance	17.1099	6,900
Custodial Services	17.1100	6,400
Drafting	17.1300	6,300
Electrical Occupations	17.1400	7,372
Electronic Occupations	17.1500	7,237
Laundry Occupations	17.1600	3,648
Foreman	17.1700	7,500
Graphic Arts	17.1900	5,025
Metal Working	17.2300	9,937
Barbering	17.2601	7,500
Cosmetology	17.2602	5,000
Fireman Training	17.2801	9,000
Law Enforcement	17.2802	9,500
Public Service, Other	17.2899	7,694
Quantity Food	17.2900	4,237
Refrigeration	17.3000	7,300
Small Engine Repair	17.3100	4,300
Stationary Energy Sources	17.3200	6,900
Textile Production	17.3300	3,876
Leatherworking	17.3400	4,300
Upholstering	17.3500	6,175
Woodworking	17.3600	4,132
Trade and Industry, Other	17.9900	6,600

TABLE AI-10

PROGRAM DATA - COEFFICIENTS

OE Code	OE Program	Pj Placement	Dj Disadvantaged	LFPRj Labor Force Participation	BSj Continuing Ed.
01.01	Production Agric.	.36	.09	.55	.24
01.02	Agr. S/S	.41	.07	.56	.13
01.03	Agr. Mech.	.41	.01	.60	.21
01.04	Agr. Products	.20	.13	.45	.25
01.05	Ornam. Hort.	.28	.13	.55	.16
01.06	Agri. Resources	.38	.13	.75	.13
01.07	Ag Res/For.	.26	.09	.38	.34
01.99	Agr. Other	.35	.07	.50	.18
04.01	APV Services	.36	.01	.51	.23
04.02	App Access	.37	.01	.55	.24
04.03	Automotive	.35	.08	.47	.16
04.04	Fin. Credit	.40	.28	.44	.33
04.05	Floristry	.29	.05	.53	.29
04.06	Food Distr.	.37	.06	.43	.21
04.07	Food Serv.	.32	.09	.48	.19
04.08	Gen. Merch.	.25	.10	.40	.16
04.09	H/BM/FG	.34	.08	.52	.27
04.10	Home Furn.	.35	.03	.53	.20
04.11	Hotel Lodg.	.20	.40	.28	.16
04.12	Ind. Market	.26	.28	.40	.21
04.13	Insurance	.50	.06	.60	.10
04.15	Person Serv.	.34	.11	.50	.16
04.16	Petroleum	.44	.09	.62	.14
04.17	Real Estate	.29	.13	.39	.19

(continued)

TABLE AI-10 (Continued)

OE Code	OE Program	Pj Placement	Dj Disadvantaged	LFPRj Labor Force Participation	BSj Continuing Ed.
04.18	Rec. Tour.	.25	.08	.33	.25
04.19	Transport	.47	.14	.74	.06
04.99	Misc. Distr.	.34	.08	.45	.23
07.0101	Dental Assist.	.51	.27	.60	.28
07.0102	Dental Hygien.	.39	.26	.51	.18
07.0203	med. Lab. As.	.10	.07	.30	.70
07.0302	Prac. Nurs.	.71	.79	.78	.04
07.0303	Nurse Aide	.34	.15	.48	.21
07.0305	Surg. Tech.	.65	.20	.68	.10
07.402	Phys. Ther. Ast.	.09	.21	.09	.27
07.0501	Rad. Tech.	.29	.26	.28	.57
07.0903	Inhal. Ther.	.00	.23	.45	.66
07.0904	Med. Asst.	.25	.20	.38	.50
07.0909	Mort. Scien.	.00	.00	.45	.20
07.99	Health Other	.29	.00	.41	.06
09.0201	Child C. - GD.	.11	.16	.39	.38
09.0202	Cl. Mgt. - P.S.	.12	.22	.33	.21
09.0203	FD Mgt. - P.S.	.23	.45	.47	.15
09.0205	Inst. H-M-S	.00	.16	.45	.20
14.01	Accnt. - Comp.	.22	.05	.36	.34
14.02	Bus. D-P-Sys.	.28	.08	.20	.21
14.03	Fil. - Off Mch.	.33	.06	.48	.23
14.0403	M/Post clk	.23	.04	.23	.19
14.0405	Mess/OB/OG	.23	.04	.23	.19
14.0499	Inf/Cm. Other	.23	.04	.23	.19
14.0503	Sh/rec Clk.	.50	.25	.50	.20

(continued)

TABLE AI-10 (Continued)

OE Code	OE Program	Pj Placement	Dj Disadvantaged	LFPRj Labor Force Participation	BSj Continuing Ed.
14.0700	Sten - Sec.	.36	.07	.48	.25
14.0899	Sp/Adm. Other	.21	.22	.38	.19
14.0900	Typing-related	.28	.16	.43	.23
14.99	Office, other	.28	.16	.43	.23
16.0101	Aeronant. T.	.45	.29	.54	.27
16.0103	Archit. Tec.	.50	.24	.58	.17
16.0105	Civil Tech.	.50	.15	.45	.20
16.0106	Chem. Techn.	.54	.15	.63	.20
16.0107	Electric T.	.50	.16	.45	.20
16.0108	Electron T.	.24	.32	.30	.39
16.0109	Elec-Mech. Tech.	.25	.16	.45	.20
16.0110	Env. Control T.	.24	.15	.45	.20
16.0113	Mech. Tech.	.62	.23	.45	.20
16.0601	Comm. Pilot	.50	.28	.55	.27
16.0699	Misc. Tech.	.50	.28	.53	.27
17.01	Air Condit.	.43	.05	.73	.03
17.0201	Elect. Appl.	.43	.04	.76	.03
17.0202	Gas Appl.	.43	.04	.76	.05
17.0301	Auto Body	.38	.05	.66	.10
17.0302	Auto Mech.	.40	.09	.63	.12
17.0303	Spec. Other	.36	.08	.58	.12
17.0401	Aircr. Main.	.36	.08	.58	.12
17.0402	Aircr. Oper.	.36	.08	.58	.12
17.0403	Ground Oper.	.36	.08	.58	.20
17.0600	Bus. Na. Rep.	.36	.24	.62	.20
17.0700	Comm. Art	.29	.04	.51	.16

(continued)

TABLE AI-10 (Continued)

OE Code	OE Program	P_j Placement	D_j Disadvantaged	$LFPR_j$ Labor Force Participation	BS_j Continuing Ed.
17.0900	Comm. Photo	.06	.00	.45	.18
17.1001	Carpentry	.30	.09	.59	.12
17.1002	Electricity	.48	.02	.67	.12
17.1003	Huy. Eq. Oper.	.42	.00	.67	.20
17.1004	Masonry	.57	.35	.78	.13
17.1005	Paint/Deco.	.36	.08	.58	.12
17.1006	Plastering	.36	.08	.58	.12
17.1007	Plumber/Pipe	.28	.01	.56	.12
17.1008	Dry Wall Ins.	.36	.08	.58	.12
17.1010	Roofing	.36	.08	.58	.12
17.1099	Other Com-Ma.	.49	.17	.59	.09
17.1100	Cost. Serv.	.28	.19	.46	.04
17.1300	Drafting	.33	.12	.53	.23
17.1400	Elect. Occup.	.38	.09	.66	.08
17.1500	Electrn. Occup.	.24	.04	.43	.27
17.1600	Laundry/Occ	.36	.08	.58	.12
17.1700	Foreman Sup.	.27	.02	.61	.15
17.19	Graphic Arts	.35	.07	.60	.12
17.23	Metal Work	.43	.05	.64	.06
17.2601	Barbering	.52	.15	.70	.06
17.2602	Cosmetology	.52	.15	.70	.06
17.2801	Fireman Tr.	.36	.08	.58	.12
17.2802	Law Enforc.	.61	.18	.77	.20
17.2899	Publ. Serv. Other	.34	.13	.40	.15
17.29	Quant. Food	.40	.12	.51	.17
14.30	Refrigeration	.37	.03	.56	.10

(continued)

TABLE AI-10 (Continued)

OE Code	OE Program	Pj Placement	Dj Disadvantaged	LFPRj Labor Force Participation	BSj Continuing Ed.
17.31	Small Eng. Repair	.17	.08	.43	.13
17.32	Stat. Em Sc.	.25	.00	.45	.20
17.33	Textile Pr.	.39	.27	.52	.16
17.34	Leather Work	.33	.00	.45	.20
17.35	Upholstrng.	.36	.08	.58	.12
17.36	Woodwork	.26	.08	.63	.12
17.99	Tr./Ind. Other	.36	.08	.58	.12

APPENDIX II

THE OPERATIONAL PLAN FOR VOCATIONAL EDUCATION IN MISSOURI THROUGH THE YEAR 1990

APPENDIX II

THE OPERATIONAL PLAN FOR VOCATIONAL EDUCATION

IN MISSOURI THROUGH THE YEAR 1990

Overview of Appendix II

The operational plan presented in this Appendix represents the efforts of Task Force 1990 to formulate a master plan for vocational education in Missouri through the year 1990. The background for the Task Force study is presented, the processes and activities are discussed, and the specific recommendations and plans are articulated. The planning model, the tools, and the techniques described in Sections I and II of this report were designed and utilized to provide the Task Force 1990 study group with a rational and empirical means of answering questions that evolved in the course of their investigation. The planning model enabled the Task Force to develop the following plan. Unfortunately, the role of the planning model in the development of the plan is not obvious. This is not surprising when one considers that the product of any process, whether it be the development of a plan or the building of a car, rarely provides insight into the precise nature of the process itself. In this case, the product resulting from the process is the operational plan presented in this Appendix.

Report of Task Force 1990: A Long Range Plan For Missouri

The rapid expansion of vocational education in Missouri was a major factor leading to the need for developing a long range planning

system. The impact of technology in the United States is such that education can no longer provide essential services effectively without planning and forethought. The systematic planning of vocational education provides an opportunity for policy makers to identify the needs of people and to formulate comprehensive plans for meeting those needs. Vocational education planning is a continuous process through which courses of action are determined in advance. The planning process seeks answers to questions about vocational education such as "Where are we?" "Where do we want to go?" "How do we get there?" "Whom do we involve?" "How do we know if we made it?"

In projecting vocational education needs through 1990 for the State of Missouri, it is important for planners to take into consideration the future impact of technology. It is equally important to plan vocational education so that it is accessible to all persons in the state who can profit from it. The Vocational Education Amendments of 1968 made a significant impact in state planning for vocational education. The legislation required that every state submit an annual and five year State Plan to qualify for federal funding. An effective State Plan must be based on a needs assessment, and should contain a valid long range plan.

In September 1974, the Missouri State Board of Education authorized a study committee for vocational education. The study committee, designated as TASK FORCE 1990, was composed of persons from state government, private business, industry and education. It was charged with the responsibility for delineating goals and objectives leading to the development of a systems approach for long range planning for vocational education in the State of Missouri through the year 1990.

TASK FORCE 1990 was charged with the responsibility of developing a blueprint for the continued growth and development of vocational education in Missouri. TASK FORCE 1990 and its working sub-committees based its recommendations on one of the most comprehensive studies of vocational education ever undertaken by a state. The emphasis throughout was on the involvement of people from all levels of government, education, business, industry and labor (Figure 1).

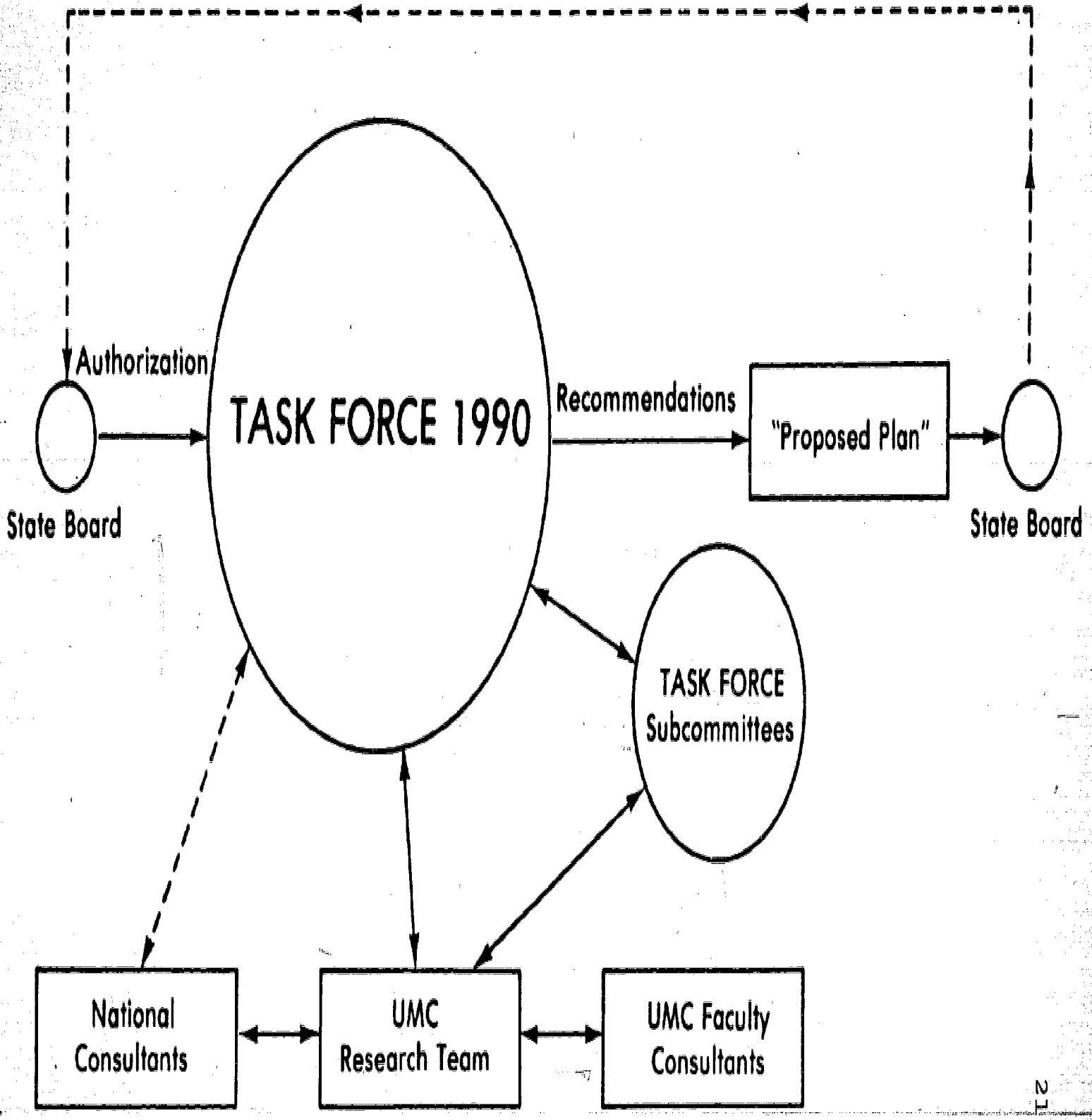
TASK FORCE 1990 recognized from the outset that "What is past is prologue." In projecting vocational education's needs through 1990, a thorough study was made of past history and present programs in vocational education. Vocational education has been on the move in Missouri. Over the past four years state funding has more than doubled. In fiscal year 1973 Missouri spent $7.3 million in state appropriated funds for vocational education. For fiscal year 1977 the state budgeted $17.4 million of state appropriated funds for vocational education. Support for vocational education has been strong in the legislative and executive branches of state government without regard to party lines. State government has recognized that vocational education can help the people of Missouri to attain better lives through continued economic development (Table 1).

In an address to the Missouri Vocational Association in Columbia on July 29, 1976 the Governor issued four challenges to vocational education in Missouri:

1. Continue to expand postsecondary and adult vocational education with emphasis on retraining of adults who may have been displaced on their job due to technological change or economic problems experienced by their employer.

AII - FIGURE 1

WORKING GROUPS - CHART OF RELATIONSHIPS



AII - TABLE 1

GROWTH IN VOCATIONAL EDUCATION ALLOCATIONS

STATE OF MISSOURI

1965-1975

FISCAL YEAR	FEDERAL GRANT	STATE ALLOCATION	LOCAL FUNDED
1965	$2,773,217	$ 889,493	$ 5,219,159
1966	5,463,983	1,188,694	10,943,183
1967	6,037,387	1,399,756	12,391,940
1968	6,316,218	3,424,205	14,218,813
1969	6,083,599	5,451,488	18,378,045
1970	8,269,785	6,237,285	18,785,355
1971	9,353,185	6,003,387	21,413,792
1972	10,838,639	6,921,013	29,060,845
1973	12,615,193	7,267,063	29,086,268
1974	11,709,319	12,267,063	32,921,606
1975	12,038,174	16,267,063	33,723,713

SOURCE: Missouri Department of Elementary and Secondary Education
Vocational Education Finance Section

2. All vocational education needs to be ready to assist in the training of skilled workers for new and expanding industries in Missouri. Our 'Jobs for Missourians Program' has been based on our ability to attract new industry by training the workers they need.

3. Vocational education must place emphasis on the future needs and demands of society. The curriculum base for vocational education should be predicted job needs. It may be simpler to base programs on student interests but vocational education should take the more difficult course of relating the curriculum to the needs of society.

4. There must be continued emphasis on the validity of vocational education programs. Vocational education must grow in quality, set standards high, keep questioning and keep evaluating.

The recommendations of TASK FORCE 1990, when implemented, will respond to these four challenges. These recommendations are presented in detail in the remainder of this Appendix.

Task Force 1990 Recommendations

A. THE NEED FOR EXPANSION OF VOCATIONAL EDUCATION OPPORTUNITIES TO MORE MISSOURIANS

Recommendations

1. It is recommended that vocational education opportunities designed to prepare youth and adults for employment be expanded by 1990 to provide for enrollment* of:

   55% of youth ages 15-18

   30% of young adults ages 19-24

   10% of adults ages 25-49 and

   2% of older adults ages 50-65

Basis for Recommendation

According to the Missouri Division of Employment Security 2,071,100 Missourians were employed in 1975. Nearly 64 percent of those employed earned their living in non-manufacturing jobs. Of those employed in non-manufacturing jobs, more than 47 percent worked in service occupations or in government. Manufacturing employment accounted for about 20 percent of Missouri employment. See Table 2.

*These percentages do not include consumer home economics.

AII - TABLE 2

HOW MISSOURIANS EARN THEIR LIVING

CIVILIAN LABOR FORCE

EMPLOYMENT CATEGORY	NUMBER	PERC
Non-manufacturing employment	1,318,700	63.7
Manufacturing employment	399,800	19.3
Agricultural employment and self-employed	352,600	17.0
Total	2,071,100	100.0
Non-manufacturing Employment		
Wholesale and retail trade	406,400	30.8
Services	305,700	23.2
Government	315,800	23.9
Transportation and public utilities	121,700	9.2
Finance, insurance, and real estate	93,200	7.1
Mining	8,500	.7
Construction	67,400	5.1
Total	1,318,700	100.0
Manufacturing of Durable Goods		
Electrical equipment and supplies	41,000	10.2
Machinery except electrical	31,900	8.0
Transportation equipment	60,200	15.0
Fabricated metal products	26,900	6.7
Primary metal industries	15,200	3.8
Stone, clay and glass products	11,700	2.9
Instruments and related products	6,300	1.6
Furniture and fixtures	7,100	1.8
Lumber and wood products	7,900	2.0
Ordnance and miscellaneous	10,600	2.7
Total	218,800	54.7
Manufacturing of Non-durable Goods		
Chemicals and allied products	26,200	6.6
Apparel and other textile products	29,700	7.4
Food and kindred products	45,300	11.3
Textile mill products	1,300	.3
Printing and publishing	33,200	8.3
Paper and allied products	12,100	3.0
Leather and leather products	22,200	5.6
Other non-durable goods	11,000	2.8
Total	181,000	45.3

SOURCE: Missouri Division of Employment Security, 1975

It is extremely important that [illegible] utilize all available [illegible] training provided is [illegible] extremely difficult [illegible] the United States [illegible]

Despite a substantial increase [illegible] vocational education [illegible] percentage of Missouri students, [illegible] vocational education increased by [illegible] shown in Table [illegible] home economics students [illegible] tional education, [illegible] enrolled in colleges [illegible] Figure .)

B. DELIVERY SYSTEMS [illegible]

Recommendations

1. It is recommended that [illegible] vocational-technical school districts, [illegible] previously designated AVTS [illegible] which are closely monitored [illegible] Vocational and Adult Education.

2. It is recommended that the following criteria be adopted and enforced by the state board [illegible] establishment of new area vocational schools:

   a. A minimum of [illegible] fewer than the [illegible] defined as practical nursing, [illegible] ture, etc. [illegible] office, agriculture, etc.

   b. A minimum [illegible] the end of the third year [illegible] after. In addition, the [illegible] cient space [illegible] 50 percent.

   c. Additional programs [illegible] school [illegible] vocational labor [illegible] board.

   d. Vocational [illegible] must be made [illegible]

   e. [illegible] available [illegible]

AII - TABLE 3

U.S. PROJECTED EMPLOYMENT GROWTH BY MAJOR OCCUPATIONAL GROUP, 1974-1985

(in thousands)

OCCUPATIONAL GROUP	1974 EMPLOYMENT	PROJECTED 1985 EMPLOYMENT	PERCENT CHANGE	OPENINGS		
				TOTAL	GROWTH	REPLACEMENTS
WHITE-COLLAR WORKERS	41,739	53,200	27.5	34,300	11,500	22,800
Professional and technical workers	12,338	16,000	29.4	9,400	3,600	5,700
Managers and administrators	8,941	10,900	21.6	5,200	1,900	3,200
Salesworkers	5,417	6,300	15.7	3,400	900	2,600
Clerical workers	15,043	20,100	33.8	16,300	5,100	11,300
BLUE-COLLAR WORKERS	29,776	33,700	13.2	12,500	3,900	8,600
Craft and kindred workers	11,477	13,800	19.9	5,100	2,300	2,800
Operatives[1]	13,919	15,200	9.0	6,000	1,300	4,800
Non-farm laborers	4,380	4,800	8.8	1,400	400	1,100
SERVICE WORKERS	11,373	14,600	28.0	11,000	3,200	7,800
FARM WORKERS	3,048	1,900	-39.0	-200	-1,200	1,000
TOTAL	85,936	103,400	20.3	57,600	17,400	40,200

[1] Includes the 1970 Census classification: operatives, except transport and transport equipment operatives.

Note: Details may not add to totals because of rounding

SOURCE: Occupational Outlook Handbook in Brief, 1976-77 Edition

AII - TABLE 4

PERCENT OF POPULATION SERVED BY VOCATIONAL EDUCATION

IN MISSOURI BY AGE CATEGORY[1]

PAST/PRESENT/FUTURE

AGE GROUP	1965			1975			1990		
	POPULATION	NUMBER SERVED	PERCENT SERVED	POPULATION	NUMBER SERVED	PERCENT SERVED	POPULATION	NUMBER TO BE SERVED	PERCENT TO BE SERVED
Secondary Age Population 15-18	295,366	23,581	8.0	358,272	72,057	20.1	294,934	162,213	55.0
Postsecondary Age Population 19-24	364,374	4,101	1.1	485,776	21,608	4.4	438,340	131,502	30.0
Adult Age Population 25-49	1,806,902	8,721	0.5	1,983,314	29,882	1.5	2,148,265	214,826	10.0
Older Adult Age Population 50-59							476,930	9,538	2.0

[1] Does not include Consumer Home Economics

SOURCE: UMC Research Team

AII - TABLE 5

STATE OF MISSOURI 1967 TO 1976 VOCATIONAL EDUCATION ENROLLMENT STATISTICS

Level of Instruction*	1967	1968	1969	1970	1971	1972	1973***	1974	1975	1976**
Secondary	31,500	36,089	38,943	46,069	46,549	50,471	50,946	68,991	72,057	73,865
Post-Secondary	4,035	6,190	8,743	9,056	11,752	14,090	8,617	14,090	21,608	22,142
Adult	24,885	25,344	26,086	27,950	26,336	36,176	19,974	27,665	29,882	35,691
Totals	60,420	67,623	73,772	83,075	84,637	100,737	79,537	110,746	123,547	131,698
Occupational Programs*										
Agriculture	15,881	16,278	16,304	16,439	17,013	17,711	13,273	22,769	21,170	20,553
Distributive Education	10,750	12,925	11,327	11,806	11,393	11,864	11,354	13,197	15,869	15,034
Health	2,343	3,015	3,381	4,378	5,050	7,394	5,332	8,049	6,513	8,208
Occupational Home Economics	1,312	1,213	1,564	1,741	1,604	2,795	2,443	1,861	6,330	7,401
Business	12,182	14,603	16,078	17,080	17,889	21,144	18,405	25,173	29,641	27,008
Technical	4,067	2,898	4,350	3,476	4,024	4,333	4,395	3,754	6,597	6,091
Trade and Industrial	13,885	16,691	20,668	23,037	25,981	30,140	21,812	33,825	35,301	45,248
Other Programs	---	---	---	5,118	1,683	5,356	2,523	2,118	2,126	2,155
Totals	60,420	67,623	73,772	83,075	84,637	100,737	79,537	110,746	123,547	131,698
Special Programs										
Disadvantaged	****	****	****	****	11,247	12,483	12,210	13,667	15,086	14,377
Handicapped	****	****	****	****	2,115	3,695	3,959	5,403	8,776	8,040
Consumer Home Economics	41,134	43,198	57,365	56,589	63,914	73,128	23,943	68,897	60,284	82,800

★ Programs Designed to Lead to Gainful Employment

★★ Projected Estimates

★★★ First Year of MOTIS - Data Incomplete

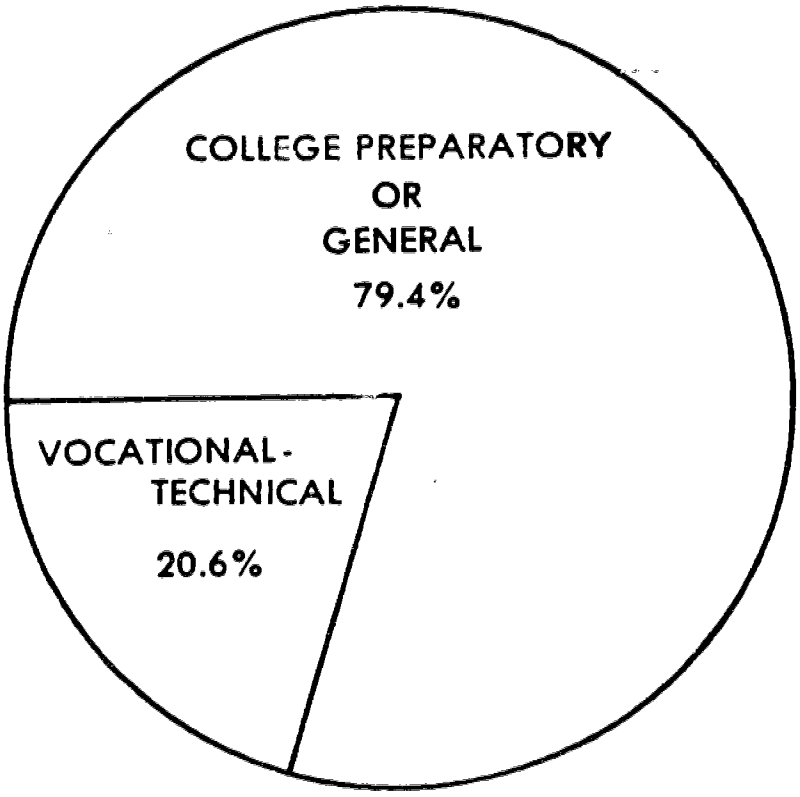
★★★★ Data Not Available

SOURCE: Missouri State Department of Elementary and Secondary Education

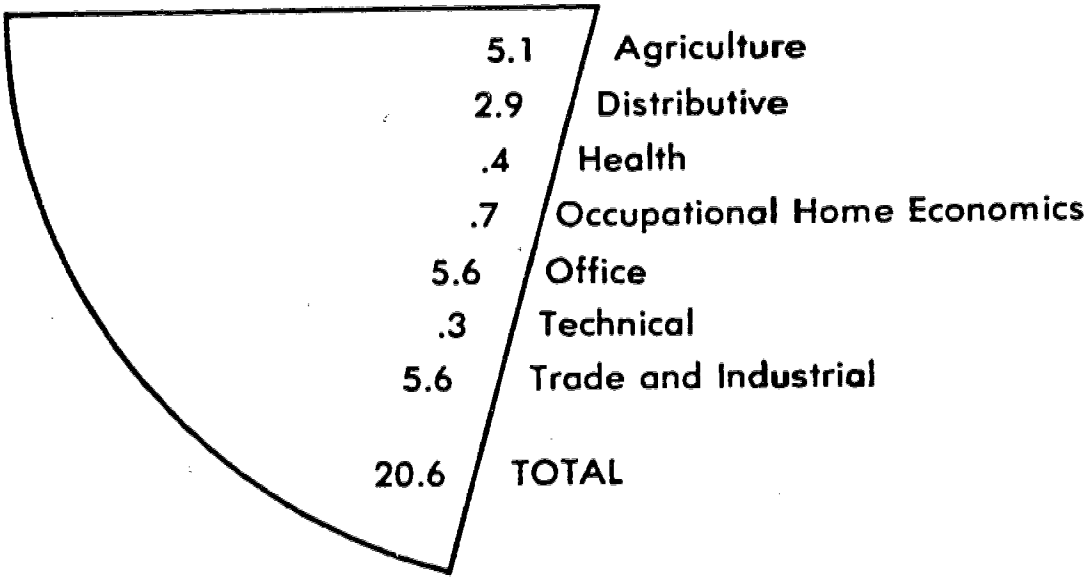
AII - FIGURE 2

PUBLIC HIGH SCHOOL ENROLLMENT DISTRIBUTION FOR 1975

GRADES 9-12



VOCATIONAL-TECHNICAL EDUCATION ENROLLMENT DISTRIBUTION



SOURCE: UMC Research Team

f. The area vocational-technical school shall be a special identifiable building with a vocational administrator in charge of its buildings and programs.

g. An area vocational-technical school director shall not be more than one step from the chief administrative officer in the organizational structure of the district and shall be a member of the administrative team of the chief administrator.

h. Participating and area schools shall have their program obligations defined by contract.

i. A functional administrative advisory committee composed of representatives of all schools which participate shall be mandatory.

3. It is recommended that the same criteria as detailed in 2 above with the exception of item "f", be adhered to by July 1, 1979, in order for a previously designated area vocational-technical school to be eligible for continued funding.

4. It is recommended that the following factors be considered in selecting the locations for new area vocational-technical schools:

   a. Concentration of students.

   b. Population density.

   c. Interest in vocational education.

   d. Availability of money to finance local share of cost.

   e. Amount of travel time to and from participating schools and the area school.

   f. Area not now being served, or capable of being served, within the travel time limitations as determined in item "e" above.

5. It is recommended that consideration be given to establishment of full-day vocational-technical schools (providing both vocational and academic education) when sparse population and other factors warrant this alternate delivery system.

6. It is recommended that area vocational-technical schools be established in areas of the state not now being served. Immediate consideration should be given to the establishment of area vocational-technical schools to serve these areas:

   a. Platte County.

   b. Southern Clinton.

   c. Southern Buchanan.

   d. Clay County.

7. It is recommended that because of a variety of factors, immediate consideration should be given to establishing full-day schools in these locations:

   a. North Central Missouri.

   b. Northeast Missouri.

   c. South Central Missouri.

8. It is recommended that vocational education in Missouri utilize to a greater extent delivery systems beyond the traditional classroom such as cooperative vocational education.

9. It is recommended that comprehensive high schools be encouraged to provide vocational education programs when area vocational-technical schools are not readily accessible or do not adequately meet the local needs.

10. It is recommended that the community colleges be encouraged to expand program offerings in vocational and technical education.

11. It is recommended that vocational education programs be increased in the service occupations and a no-growth policy be adopted in areas where employment opportunities are limited.

Basis for Recommendations

The area vocational-technical school which is designed to provide a concentration of quality vocational education programs in one location should be made accessible to all Missourians. Criteria for establishment and continued operation of area vocational-technical schools must assure that enrollments are large enough to provide comprehensive vocational education programs at the lowest possible cost. Area vocational-technical school facilities should be designed with flexibility to provide for future expansion or deletion of course offerings as needs change. Area vocational-technical schools can provide for many of the more specialized and expensive to operate vocational offerings such as data processing or machine tool operations. Comprehensive high schools can be an important part of the delivery system if their course offerings are carefully selected and limited to areas they can perform well.

The location of 54 presently designated area vocational-technical schools is shown in Figure 3. (Additional information concerning area school enrollment and program offerings is included in Appendix F.)

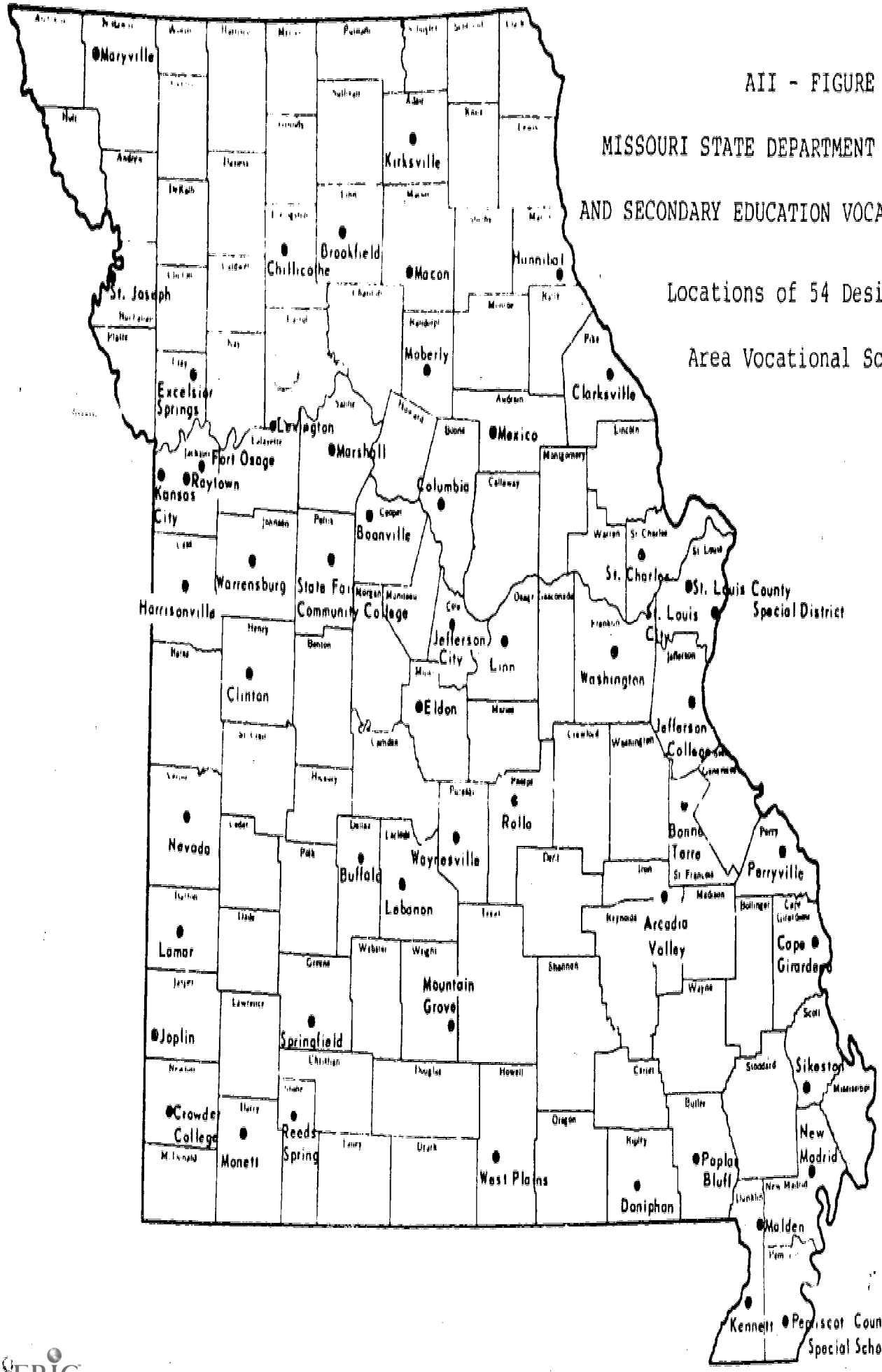
AII - FIGURE 3

MISSOURI STATE DEPARTMENT OF ELEMENTARY

AND SECONDARY EDUCATION VOCATIONAL DIVISION

Locations of 54 Designated

Area Vocational Schools



C. ADMINISTRATION OF VOCATIONAL EDUCATION

Recommendations

1. It is recommended that a study be made of the desirability and feasibility of a single state board for the administration and coordination of all educational programs including vocational education in the State of Missouri.

2. It is recommended that vocational education continue to be administered by a single state board for vocational education under the direction of an assistant commissioner of education (state director of vocational education).

3. It is recommended that a single state agency be responsible for allocating all state and federal vocational education funds including the planning, supervision and appraisal of vocational education programs at all levels.

4. It is recommended that state vocational education administrators develop a state-wide vocational education plan that specifies measurable and attainable objectives as well as target dates for meeting these objectives.

5. It is recommended that state level vocational education administrators take a leadership role in planning and coordinating vocational education programs to bring about positive change.

6. It is recommended that the State Board of Education reorganize the formal structure of the Division of Career and Adult Education by function. The functions of administration and occupational specialists should be separated and the present orientation toward traditional occupational programs should be de-emphasized. The Division should be renamed the Division of Vocational and Adult Education.

7. It is recommended that Vocational and Adult Education Administrative Service Regions be established under the direction of a regional coordinator responsible to the proposed Division of Vocational and Adult Education.

8. It is recommended that administration of vocational education at the local level be strengthened by providing in the State Plan that the local administrator of vocational education shall not be more than one step removed from the chief school administrator in the local organizational structure.

9. It is recommended that the proposed Division of Vocational and Adult Education establish a business and industrial training unit staffed with appropriate personnel to work in direct liaison with the Division of Commerce and Industrial Development, the State Employment Service, CETA prime sponsors, and other related agencies so that they may act quickly and flexibly in committing funds for business and industrial training.

Basis for Recommendations

The governance of education at the state level is a topic of great concern throughout the nation. All education, regardless of level and institutional setting, should be administered from a single state body responsible to the people.

The concept of the single state agency to administer vocational and technical education assures that authority, responsibility and accountability are clearly spelled out. The single state agency in Missouri is the State Board of Education, which is designated as the State Board for Vocational Education. This single agency should be held accountable for meeting the State of Missouri's needs for training skilled manpower.

The administrative functions of the Division of Vocational and Adult Education can be more efficiently performed by dividing the state into Vocational and Adult Education Administrative Service Regions. The regions could coincide with the elementary and secondary education supervisory districts currently designated or with other regionalization plans now in operation. MOTIS regions should conform with the vocational and Adult Education Administrative Service Regions (ASR).

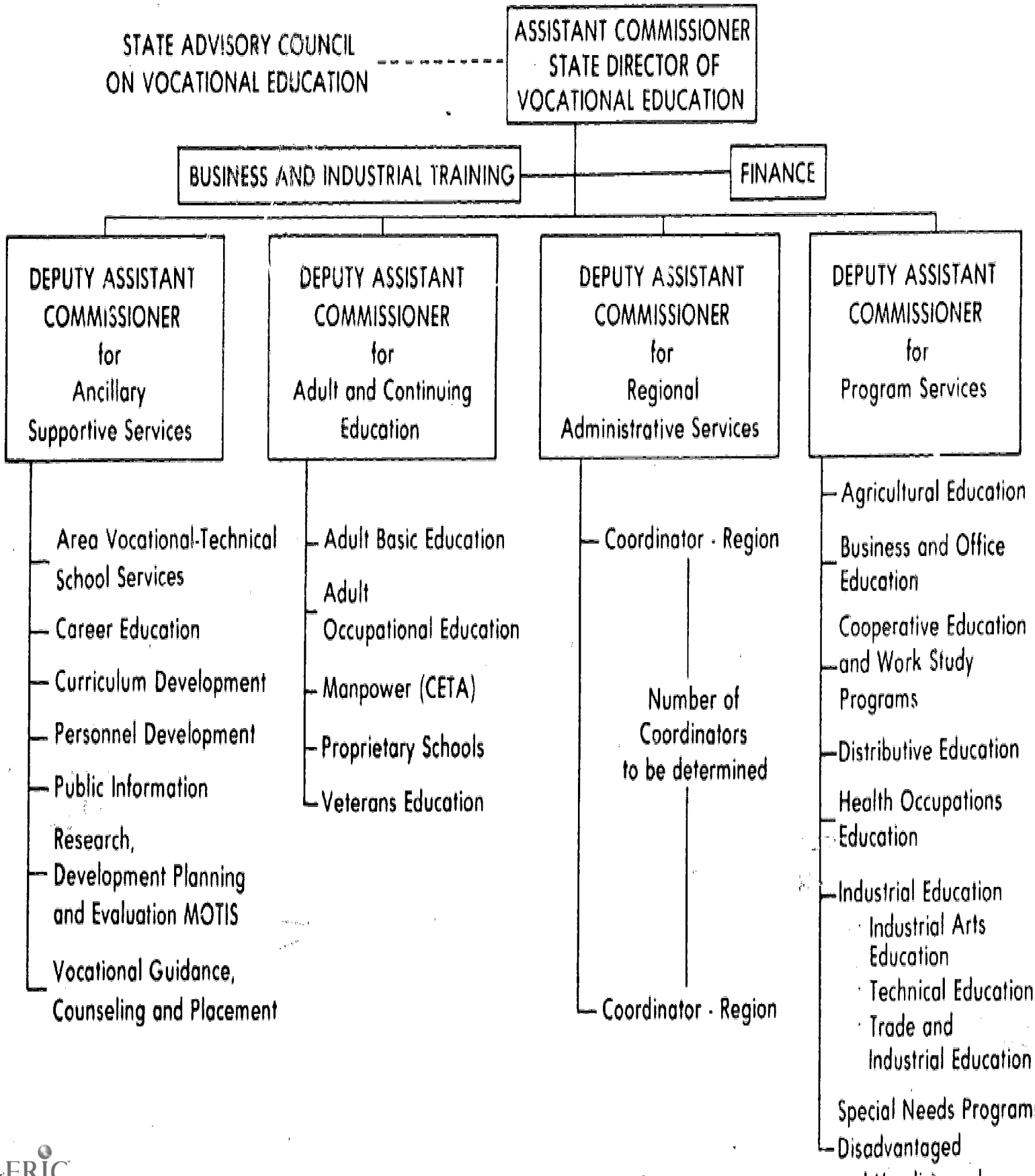
The key elements of organizational structure are the people who are part of it. Missouri is fortunate to have a competent and dedicated group of persons in the present Division of Career and Adult Education despite staff salaries which are considerably below that paid for comparable responsibilities in local school administration, in college and university professorships and in business and industrial training positions.

Recent changes in vocational education legislation have resulted in a change from occupational and service area orientation to a people-needs organization. A suggested functional organizational structure for administration of vocational and adult education at the state level is shown in Figure 4. This revised administrative structure has the potential to serve as a catalyst for change.

Providing start-up training for new plant workers is often an important factor in attracting industry to a state. Experience in several states has indicated that start-up training for new industry is expedited more efficiently when initiated, directed and coordinated from the state level. Other states have established special units in the state vocational education agency to provide flexibility in such training for new and expanded industry. Industry start-up training conducted from the state level makes it possible to provide training on a short lead time basis where such was not budgeted by a local educational agency. If left entirely to a local educational agency, start-up training might go undone because facilities are usually committed to ongoing occupational education programs. The proposed business and industrial training unit reporting directly to the state director of vocational education would be responsible for this activity.

AII - FIGURE 4

DIVISION OF VOCATIONAL AND ADULT EDUCATION SUGGESTED ORGANIZATIONAL CHART



D. FINANCE

Recommendations

1. It is recommended that the systems approach be used in the funding process employed to deliver vocational education programs, services and activities across the State of Missouri. By utilization of the systems approach in financing vocational education, it will make it possible for finance to be used as a management tool.

2. It is recommended that planning for vocational education be given adequate lead time. It is particularly important that financial planning including committing of funds for the following school year, be approved at least several months in advance.

3. It is recommended that a variable funding formula be developed for the financing of vocational education. Such a formula will help to insure the programs with the largest benefits relative to cost would receive priority and would be financially rewarded by receiving a higher level of funding than those programs with less benefits relative to cost.

4. It is recommended that financial management of vocational education in Missouri be based on information collected and systematically applied on an on-going basis to make a new funding formula effective. Such information would include student enrollments, projected employment, program costs, numbers of individuals prepared by other training sources, and placement rates.

5. It is recommended that vocational education finance be used as a means of ensuring quality control of vocational education at the local level.

6. It is recommended that adequate funds be provided to the local educational agencies so that they may develop and maintain active school-based job placement services for all vocational education students in cooperation with Missouri State Employment Service.

7. It is recommended that sufficient funds be provided to achieve the goals called for in recommendation A1.

Basis for Recommendations

A thorough review of the present financial structure of the vocational education delivery system in Missouri was made. There was no predisposed notion that more money would automatically solve all of the problems. Rather, ways were explored to save or reallocate funds by improved financial planning. Analysis of cost data for vocational education in Missouri was most difficult because the bookkeeping methods of most local educational agencies are not geared to the systems approach. A great deal of effort was expended on reviewing

alternative formulae for allocation of vocational education resources through 1990. The State of Missouri currently provides minimum reimbursement to local educational agencies as follows:

a. Comprehensive high school - $200 per full-time teacher month employed.

b. Area vocational school - 50 percent of the instructional salaries.

c. Junior college - $120 per credit hour of approved credit.

d. Adult - 75 percent of instructional salaries.

The problem with the present system of finance is that it does not reflect the cost per student for individual occupational areas nor does it provide incentives for increased enrollments or program improvement. (Included in Appendix D is an example of a formula which takes into account the factors of manpower needs and job opportunities, vocational education needs, relative ability to pay, and excess costs.)

If the increased vocational education enrollments projected by TASK FORCE 1990 are to be achieved, considerably more funds must be allocated by 1990. Table 6 provides gross vocational education enrollments and expenditures past, present and future.

E. LEGISLATIVE

Recommendations

1. It is recommended that legislation be enacted which would permit school districts jointly to provide for establishment of a special school district for vocational-technical education and/or other types of education. Such a district would be administered by a separate board and a superintendent.

2. It is recommended that legislation be enacted to require private proprietary vocational-technical schools to meet acceptable state standards and to secure approval to operate in the state.

3. It is recommended that legislation be enacted to permit local eduational agencies to contract for training services with a properly certificated, state approved and regulated private vocational-technical institution when student needs cannot be met in a public school and when the costs do not exceed the costs for a similar program in publicly supported local educational agencies.

4. It is recommended that existing legislation be repealed which requires vocational education teachers to take a course dealing with the education and psychology of exceptional children.

AII - TABLE 6

VOCATIONAL EDUCATION ENROLLMENTS AND EXPENDITURES

PAST/PRESENT/FUTURE

1975 Dollars

YEAR	ENROLLMENT[1]	EXPENDITURES[2]
1965	30,644	$ 10,339,898
1975	123,547	41,687,229
1980[3]	270,050	91,120,271
1990[3]	518,079	174,810,220

1. Secondary, post-secondary, and adult enrollments are combined.

2. Expenditures are adjusted to offset the inflation factor to 1975 dollars and to exclude consumer home economics.

3. Projected enrollments based on TASK FORCE 1990 recommendations for percentages to be served.

   Projected expenditures based on 1975 per student expenditure of $337.42

SOURCE: Missouri Department of Elementary and Secondary Education

Basis for Recommendations

Present Missouri law provides that voters may organize and create special districts for the primary purpose of both (1) educating and training handicapped and severely handicapped children; and (2) providing vocational education. Since residents of special districts are not always willing to provide both services, the law should be changed to permit voters to provide for the establishment of special school districts for vocational-technical education and/or other types of education.

Under present law private proprietary vocational-technical schools are not required to meet state standards or secure approval of a state agency for operation. We believe that this should be required to guarantee quality in vocational-technical programs made available to Missouri citizens.

In order to make vocational-technical education programs available to all citizens, legislation should be passed to permit school districts to contract with properly certificated, state approved and regulated private institutions when needed programs are not available in public educational institutions.

The law requiring all teachers to complete a course dealing with the education and psychology of exceptional children makes it impossible to fill some vocational-technical teaching positions.

F. BUSINESS, INDUSTRY, LABOR INVOLVEMENT

Recommendations

1. It is recommended that every local educational agency, prior to receiving reimbursement for vocational education programs, be required to submit evidence that an active and functional advisory committee is in operation.

2. It is recommended that the proposed Division of Vocational and Adult Education establish regional workshops throughout the state dealing with effective operation and utilization of advisory committees. Such workshops should be open to all vocational education personnel, school administrators, counselors and advisory committee members.

3. It is recommended that the proposed Division of Vocational and Adult Education develop and disseminate specific contemporary guidelines to be used by advisory committees at all instructional levels.

Basis for Recommendations

Vocational education needs the support of the community, and of labor, industrial and business interests that strong advisory

committees can create. Labor organizations and management groups can be either passive or enthusiastic supporters of vocational education; the degree of their support will depend on the extent to which they have been consulted and involved. A vocational education advisory committee representing joint labor-management interests can usually enlist the maximum support and cooperation of business and industry in the community.

Advisory committees in occupational education are organized to advise and counsel the school administrators and to make suggestions and recommendations for the guidance of the state and local boards. A principal function is to provide closer cooperation and better understanding of occupational education in the community, the home, and the school. An advisory committee provides a two-way system of communication between the school and the community, which is highly desirable for all education programs. An educational advisory committee, either at a national, state, or local level, has no administrative or legislative authority. The very name signifies its function. Whether it is called a board, commission, council, or committee, its function is to give advice and lend assistance for program improvement.

G. ARTICULATION AND COORDINATION

Recommendations

1. It is recommended that the State Board of Education, in cooperation with the Department of Higher Education and the Department of Social Services, appoint a task force charged specifically with developing a working articulation model. The model should be developed with the aim of providing for continuous educational progression of students with a minimum of attrition and maximum efficiency which will provide opportunities for students to progress on a continuum from one level of education to the next.

2. It is recommended that the State Board of Education, in cooperation with the Department of Higher Education and other appropriate state agencies, establish an inter-agency council charged with the responsibility of developing a formalized relationship between government agencies, including the roles and responsibilities of each ensuring a coordinated effort in the administration and supervision of vocational education in training for employment.

3. It is recommended that a formalized relationship for coordination should include a plan for continuous monitoring, evaluating, and reporting the quality and effectiveness of the relationships among the various agencies.

4. It is recommended that a system be established to permit the transfer of credit earned in approved postsecondary programs between area vocational-technical schools, community colleges, technical institutes or other institutions of higher education within the state.

Basis for Recommendations

The problems related to the articulation of secondary and postsecondary vocational education are not new to most state and local educational agencies.

The term articulation as used in this study refers to the process of transfer and progression of students from one level of vocational education to the next. More specifically, the articulation process was regarded as the extent to which the secondary and postsecondary levels in the educational system provide for the continuous educational progress of students with minimum of repetition and maximum of efficiency.

The major goals of articulation in vocational education should be to provide students an opportunity to develop their highest potential without unnecessary duplication of instruction and delay in reaching their occupational objective.

Articulation of secondary and postsecondary vocational education in Missouri is, in general, neither appreciably better nor worse than articulation in other states. Only two Missouri community/junior colleges recognize high school work completed in similar vocational studies by granting credit without examination. A problem of articulation exists between postsecondary vocational programs offered in the public schools and those offered in the community/junior colleges.

Articulation in vocational education is a team process--a series of complex and interlocking formal and informal relationships between schools. Effective articulation demands positive attitudes among institutional leaders. Differences in institutional philosophy are not always identifiable, and individual prejudices are often hard to overcome. Willingness to compromise extreme positions and to tolerate the views of others is essential if articulation of vocational education between secondary and postsecondary institutions is to succeed in Missouri. Junior colleges do not usually grant college hours for vocational courses transferred from postsecondary programs in the public schools. However, some exceptions have been made for high quality courses when the courses are approved in advance by the junior college.

H. RESEARCH AND DEVELOPMENT, PLANNING AND EVALUATION

Recommendations

1. It is recommended that a vocational education research, development, planning and evaluation unit be established within the proposed Division of Vocational and Adult Education. The work of this unit would be closely coordinated with other appropriate units of the Department of Elementary and Secondary Education and other governmental and educational agencies. The research, development, planning and evaluation unit would be responsible for functions such as:

a. Determine research and development priorities through periodic state-wide surveys of vocational education personnel.

b. Utilize on a continuous basis, a research advisory committee representing consumers as well as producers of vocational education research to interpret the research priorities.

c. Coordinate the review and processing of research proposals for funding.

d. Administer and monitor vocational education research and development contracts and grants.

e. Coordinate the development of goals and objectives for vocational education which are attainable and measurable.

f. Develop projections and formulate recommendations for allocation and use of resources based on appropriate planning data.

g. Coordinate evaluation with program planning.

h. Disseminate vocational education research and development information.

i. Provide professional assistance to those engaged in vocational education research by assisting and developing, conducting, and reporting studies.

2. It is recommended that the current Management Information System entitled MOTIS (Missouri Occupational Training Information System) be part of the proposed research, development, planning and evaluation unit and be fully financed and implemented. More effective use of MOTIS can be achieved by requiring that:

a. Local educational agencies develop and submit plans for vocational education programs that are supported by MOTIS generated data prior to approval for funding.

b. Establishment of new vocational education programs be based upon projected job openings and the number of individuals being prepared by all other training sources.

c. Continuation of existing vocational education programs be based upon adequate completion and placement rates for the program.

d. Evaluation of vocational education programs be based upon the ability to place students in occupations related to the training they have received.

e. Manpower projections be integrated into the program planning process at the state and local level so that a mix of vocational education programs can be offered that mirror projected employment opportunities.

f. Stringent auditing procedures be established to assure that local education agencies provide accurate and timely baseline data to the department's management information system (MOTIS).

g. MOTIS be charged with the responsibility for organized data collection and dissemination in a manner which will ensure its effectiveness in planning and evaluation activities at the state, regional, and local levels.

3. It is recommended that a substantial investment be made in vocational education research addressed to the following priorities:

   1. Planning Vocational Education
   2. Curriculum Development
   3. Evaluating Vocational Education
   4. Needs Assessment Studies
   5. Organizing and Managing Vocational Education

Basis for Recommendations

Seventy-one percent of a sample of 221 vocational educators returned a mailed questionnaire dealing with research priorities for Missouri's vocational education system. Surveyed were members of the vocational education staff of the Missouri Department of Elementary and Secondary Education (MDESE), area vocational school directors, community college occupational deans, vocational education teacher educators, and individuals receiving vocational education research grants over the previous three year period. The overall ranking and group rankings for the top five priorities are listed in Table 7. Teachers, researchers, and MDESE personnel were similar in their rankings.

Sixty-four area vocational school directors and occupational deans in community colleges were mailed a survey instrument dealing with vocational education planning in Missouri. Of the fifty-six administrators that returned the instrument, 77 percent indicated that planning was the most important function they performed. Over 80 percent agreed that labor market information should be the prime factor in planning vocational education programs. This expressed emphasis on planning vocational education was accompanied by supportive statements regarding the need for more and better planning. Eighty-two percent of the respondents expressed a need for a state planning guide or handbook. Ninety-one percent favored the need for workshops and in-service training sessions on planning. Approximately half of the respondents indicated that current state-wide vocational educationa management information system (MOTIS) was not a helpful planning tool. A number of respondents expressed the need for improved data and planning assistance from state vocational education leaders.

AII - TABLE 7

A RANKING OF VOCATIONAL EDUCATION RESEARCH PRIORITY AREAS

BY VOCATIONAL EDUCATORS

PRIORITY AREA	(1) Total Group	(2) State Adm.	(3) AVTS Div.	(4) Occ. Deans	(5) Voc. Ed. Teachers	(6) Voc. Ed. Res.	(7) Voc. Ed. Tch. Eds.
PLANNING VOCATIONAL EDUCATION	1	1	1	5	2	2	2
CURRICULUM DEVELOPMENT	2	2	4	1	1	1	5
EVALUATING VOCATIONAL EDUCATION	3	3	3	2	-	4	4
NEEDS ASSESSMENT STUDIES	4	4	-	4	-	3	1
ORGANIZING AND MANAGING VOCATIONAL EDUCATION	5	5	2	3	3	-	-

1. Total Group
2. State Vocational Education Administration
3. Area Vocational-Technical School Directors
4. Occupational Deans of Community Colleges
5. Vocational Education Teachers
6. Vocational Education Researchers
7. Vocational Education Teacher Educators

SOURCE: UMC Research Team - - Questionnaire distributed to sample groups during the 1975-76 school year.

A national survey of organizational patterns in state departments of education revealed that most states have units for vocational education planning, evaluation and research coordination. These functions were found to be under the direct supervision of the state director of vocational education. Expert testimony supported the need for such a unit in the Missouri Division of Vocational and Adult Education.

I. CURRICULUM DEVELOPMENT

Recommendations

1. It is recommended that a systematic approach be developed to ensure that vocational education course content be kept current with the needs of employers and its relevance to the placement of students on jobs be maintained.

2. It is recommended that a centrally coordinated exemplary curriculum project be developed developed dealing with competency-based instruction, self-paced learning, and other contemporary instructional systems.

3. It is recommended that the importance of problem solving and attitudinal development receive increased emphasis in vocational education curricula.

4. It is recommended that the existing Missouri Vocational-Technical Curriculum and Instructional Materials Laboratory at the University of Missouri-Columbia be expanded with appropriate resources and personnel to provide state-wide leadership for coordination and management of curriculum development services. Such services should include a closer cooperation with employers and the development of a state-wide clearing house of vocational education instructional materials at all levels.

5. It is recommended that a vocational education curriculum development council be appointed to advise the Missouri Vocational-Technical Curriculum and Instructional Materials Laboratory. The council should develop policy and determine goals.

6. It is recommended that secondary vocational education curricula move toward the cluster approach to vocational education that emphasizes families of occupations and away from programs that prepare youth for specific jobs in narrow occupational categories.

Basis for Recommendations

Vocational educational curricula and instructional materials must be frequently revised so that programs adjust to changes in technology occurring in the business and industrial fields. A great deal of emphasis has been placed recently on utilization of the cluster concept of instruction in vocational education. The cluster concept

groups occupations into job families such as health, transportation, construction and communications. The cluster concept emphasizes the development of a broad array of entry level skills in a job family rather than very specific, narrow skill-training.

The Missouri Vocaitonal-Technical Curriculum and Instructional Materials Laboratory located at the University of Missouri-Columbia has provided a central focus for development of new curriculums and instructional materials. Missouri is affiliated with the 12-state Mid-America Vocational Curriculum Consortium which cuts down on the duplication of effort in the states and results in higher quality curriculum materials as well as reduction in costs. The Consortium cooperatively develops needed curriculum materials that any one state would not be likely to develop on its own.

The Missouri Vocational-Technical Curriculum and Instructional Materials Laboratory at UMC has a policy making board of five UMC program coordinators for the major vocational service areas offered at the University. The services provided should be expanded to better serve the total needs of the entire state by establishment of a broadly representative statewide Vocational Education Curriculum Coordinating Council and by providing additional resources for staff, equipment and facilities.

J. PERSONNEL DEVELOPMENT

Recommendations

1. It is recommended that in-service and pre-service programs for vocational educators be developed to emphasize the integration of the vocational aspects of education with the total education of each individual.

2. It is recommended that a plan for vocational education personnel development in Missouri be developed based on the need for and supply of qualified personnel in the various occupations in the state.

3. It is recommended that vocational education teachers be prepared to assume teaching roles in alternative education delivery systems.

4. It is recommended that vocational education teacher preparation programs and in-service programs consider the utilization of the cluster concept.

5. It is recommended that in-service and pre-service educational experiences be provided to acquaint all elementary and secondary educators with the needs and demands that business and industry will place upon students when they terminate formal education.

6. It is recommended that the Missouri State Board of Education be the sole certification agency for vocational education personnel.

7. It is recommended that vocational education certification be based in the future upon competency-based teacher certification at both the entry and advanced levels.

8. It is recommended that all vocational education personnel at the secondary, postsecondary and adult education levels, whose entry level certification is based on college degrees, must have completed specific work experience and/or internship requirements as well as specific college course requirements prior to their entry into teaching the occupational areas.

9. It is recommended that financial incentives be provided to encourage the preparation of professional vocational education personnel in areas where distinct shortages exist.

10. It is recommended that the Department of Elementary and Secondary Education staff develop criteria to determine that all counselors whose salaries are partially or fully paid by state or federal vocational education funds understand vocational guidance, vocational curriculum development and the philosophy of vocational education.

11. It is recommended that in teacher education programs conducted in institutions of higher education and in-service programs designed for teacher improvement, attention be given to developing personnel with special skills in job placement, vocational education for special needs, planning and evaluation, curriculum development and the effective use of advisory councils.

12. It is recommended that non-degree vocational education personnel who receive entry level certification present evidence of competence and work experience in their occupational specialty.

Basis for Recommendations

High quality professional personnel at all levels are essential to quality vocational education programs. Professional vocational education personnel are unique in that they must possess occupational experience in addition to meeting requirements for certification. Adequate resources must be made available to provide the great diversity of pre-service and in-service programs that are needed.

Table 8 indicates the higher education institutions in Missouri that have specific programs for preparing professional personnel for vocational education. The number of graduates from these institutions by vocational education service area in 1975 is given. Table 9 indicates the major professional activity of a sample of vocational

AII - TABLE 8

VOCATIONAL EDUCATION GRADUATES FROM INSTITUTIONS OF HIGHER EDUCATION

1975

INSTITUTION	LEVEL	AGRICULTURE	BUSINESS	DISTRIBUTIVE	HOME ECONOMICS	TRADE AND INDUSTRIAL	VOCATIONAL	GUIDANCE	TOTAL
Central Missouri State University - Warrensburg	B. S.	–	30	10	38	–	–	–	78
	Grad	–	15	9	4	–	–	48	76
Lincoln University - Jefferson City	B. S.	–	11	–	5	–	–	–	16
	Grad	–	–	–	–	–	–	–	–
Northeast Missouri State University - Kirksville	B. S.	–	26	–	19	–	–	–	45
	Grad	–	10	–	–	–	–	46	56
NorthwestMissouri State University - Maryville	B. S.	–	11	–	29	–	–	–	40
	Grad	–	3	–	–	–	–	26	29
Southeast Missouri State University - Cape Girardeau	B. S.	–	33	–	43	–	–	–	76
	Grad.	–	4	–	–	–	–	35	39
Southwest Missouri State University - Springfield	B. S.	–	28	–	22	–	–	–	50
	Grad	–	–	–	–	–	–	34	34
University of Missouri - Columbia	B. S.	31	15	5	28	10	–	–	89
	Grad	14	9	7	13	28	15	85	171
University of Missouri - Kansas City	B. S.	–	–	–	–	–	–	–	–
	Grad	–	–	–	–	–	–	114	114
University of Missouri - St. Louis	B. S.	–	–	–	–	–	–	–	–
	Grad	–	–	–	–	–	–	82	82
TOTALS	B. S.	31	154	15	184	10	–	–	394
	Grad	14	41	16	17	28	15	470	601

SOURCE: UMC Research Team

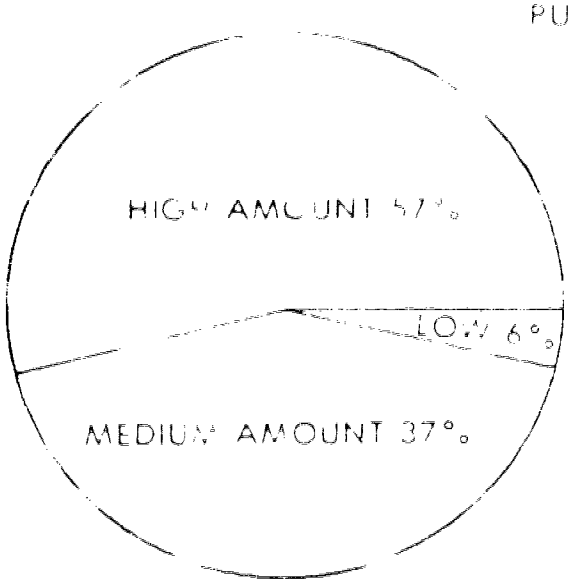
THE MAJOR PROFESSIONAL [illegible]

PRIOR TO JOINING THE MISSOURI [illegible]

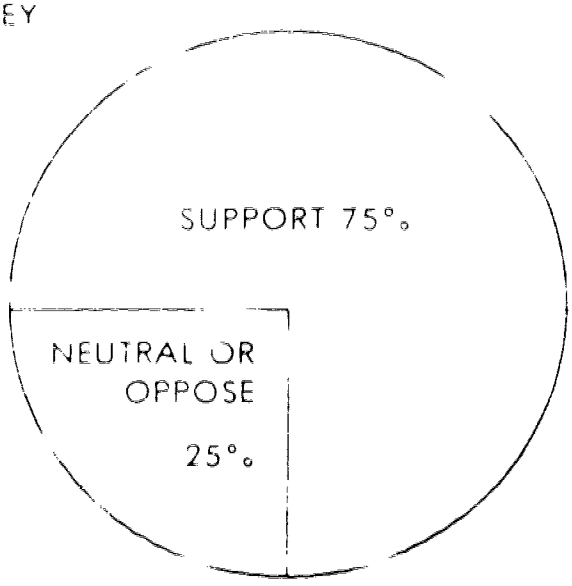
ACTIVITY	AGRICULTURE	BUSINESS	DISTRIBUTIVE	[illegible]
Employed in Business and Industry	2	2	7	[illegible]
Student Teacher In Vocational-Education Program	26	8	10	
Student in College In a Non-Vocational Program	1		-	
Teaching Vocational Education In High School	2	2	2	
Teaching Academic Subjects In High School	1	15	10	
Teaching Vocational Education In Another State	2	-	-	
Self Employed, Homemaker, or Military	1	2	3	[illegible]

SOURCE: UMC Research Team - Based upon [illegible] teaching during [illegible]

PUBLIC SURVEY

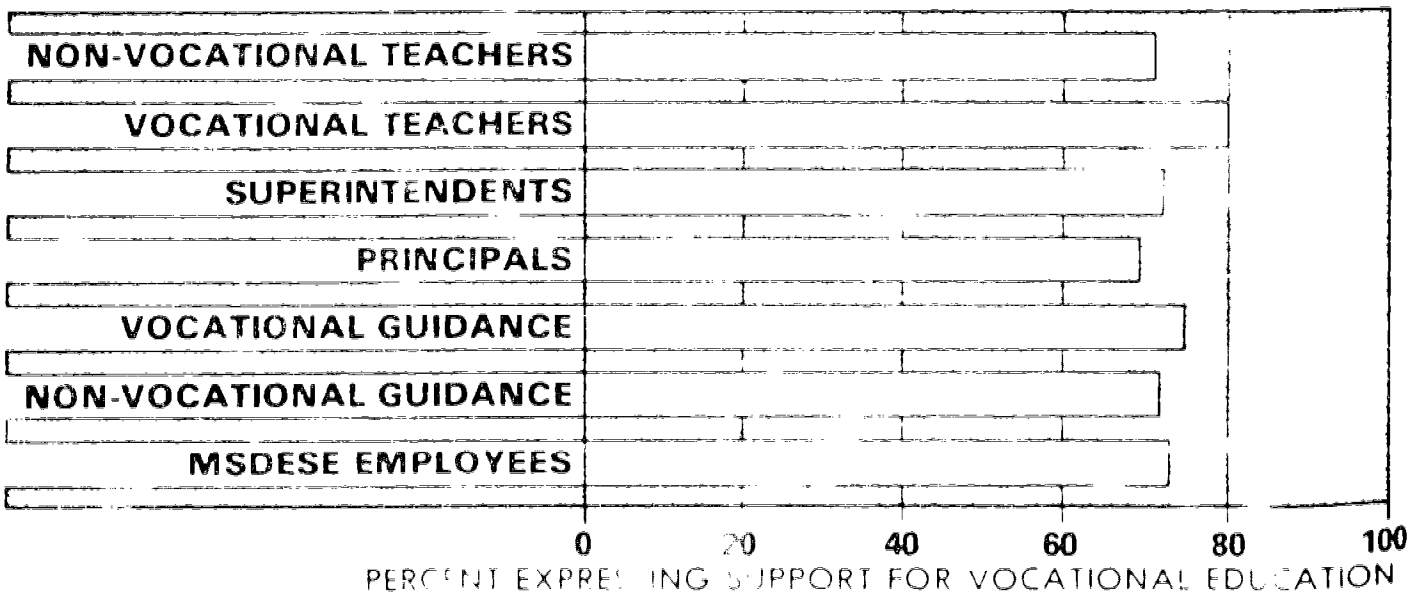


How much should vocational education be emphasized in the overall educational program?



Would you support or oppose a tax increase for improved vocational education?

MISSOURI EDUCATORS' SURVEY
OVERALL SUPPORT RATING OF VOCATIONAL EDUCATION



both boys and girls. Recruitment for vocational education programs has often emphasized differences between programs for boys and those for girls. Instructional materials have many times been biased in such a manner as to discourage girls from pursuing certain vocational education programs. Relatively few women have been able to achieve high level administrative leadership positions in area vocational-technical schools, in the administration of local vocational education programs or in state educational agencies.

Youth unemployment and school dropout rates are extremely high in St. Louis, Kansas City and other urban areas. For minority youth in the inner city the unemployment rate is more than double that of white youth. TASK FORCE 1990 site visits to Kansas City and St. Louis indicated that there was a lack of interest and an apparent low enrollment in many vocational offerings.

Summary

In this Appendix specific recommendations were made for the future of vocational education in Missouri. The recommendations were the result of a study known as TASK FORCE 1990. This study involved clients and constituencies of vocational education from business, labor, government, and citizens groups. The involvement of these groups in the strategic planning of vocational education can serve as a model for other states to follow in the development of their annual and five year plans.

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